UNIT I

NATURE OF ENVIRONMENATAL STUDIES AND NATURAL RESOURCES

Definition: The word "Environment" is derived from the French word "Environ" means encircle which implies 'Surrounding'. Environment is defined as "the sum total of water, air and land and the inter-relationships that exist among them and with the human beings other living organisms and materials".

Environment consists of following three components

a) Abiotic or Non-living component
b) Biotic or living components
c) Energy components

Classification of Environment: It is broadly classified into two types. They are Natural Environment and Man – made Environment which is discussed as follows:

Natural Environment: The natural environment consists of four systems, *i.e*, atmosphere, hydrosphere, lithosphere and biosphere.

Atmosphere: The air that covers the earth is known as the atmosphere. It is essential for living organisms. The atmosphere contains gases like oxygen, N_2, H_2, CO_2, H_2O etc.

Hydrosphere: The aqueous layer of the earth is known as the hydrosphere. It includes the ocean, lakes, streams and surface water, water vapour in the atmosphere and water in the form of ice.

Lithosphere: The soil component of earth is called lithosphere. The lithosphere includes four main layers: crust, mantle, outer and inner layer.

Biosphere: It contains living organisms that interact with environment (i.e., air, water and land). Under the natural circumstances the microbes, plants and animals interact with each other's life directly and indirectly. The interactions of organisms with other systems are represented as in Fig. 1.1.

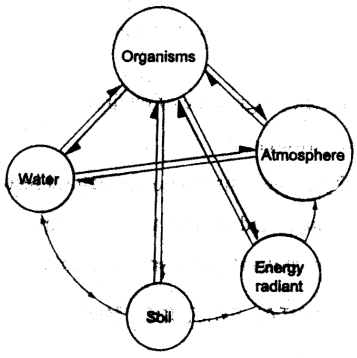


Fig. 1.1. Interrelationship between Principal Components of Environment

Man – made Environment: The environment which has been modified by human activities is called Man – made environment. Man is modifying the environment according to his own needs. Man applied the advanced scientific technologies for comfortable life.

Definitions:

Environmental Science: Environmental Science deals with the interrelationship between biotic and abiotic component present in the environment.

Environmental Engineering: Environmental engineering is the study of the technical processes which are used to minimize the pollution and to assess the impact of pollution on environment.

Scope of the Environmental Studies: The scopes of the environmental studies are summarized as follows:

i) Studying the interrelationship between biotic and abiotic components.
ii) Carrying out the impact analysis and environmental auditing in order to minimize the environmental problems.
iii) Reduce the pollution from existing and new industries.
iv) Stopping the use of biological and nuclear weapons for destruction of human race.
v) Managing the unpredictable disaster.
vi) To create awareness to the public.

Importance of Environmental Studies: Some of the importance of environmental studies as listed below:

i) Environmental studies providing information about the conditions of environment and potential environment problems which could be useful during the planning and designing stages of the project.
ii) It provides the knowledge about ecological systems, causes, effects and relationship between the components.
iii) It provides necessary information about biodiversity richness and the potential dangers to the species of plants, animals and micro - organisms in the environment.
iv) Environmental study is a key instrument for bringing about the changes in the knowledge, values behaviours and life styles required to achieve sustainability and stability within and among the countries.

v) Environmental studies are also used to assess and to solve the big environmental problems that include:
   a) **National environmental problems:** Air pollution due to industries and automobiles, urban, industrial and medical solid waste, deforestation, desertification etc.,
   b) **Global Environmental Problems:** Overexploitation of natural resources, green house effect, acid rain and ozone layer depletion etc.

Need for Public awareness:

Objectives

i) To identify various plants and animals and other components of the environment that are endangered.
ii) To take appropriate decisions regarding the use of natural resources.
iii) To conserve nature and natural resources for society from the point of view of social, cultural and economic development.
iv) To adopt appropriate ways and means to solve existing environmental problems.

Important methods that may be adopted for propagating public awareness are as follows.

Environmental Education: Environmental education can be introduced as course in schools and colleges. It is the most successful method for propagating environmental awareness. This course spreads awareness regarding the protection of environment.

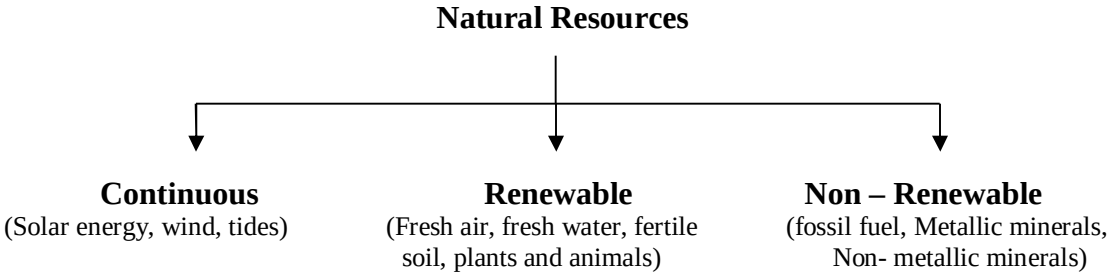
Through mass media: Mass media such as newspapers, magazines, radio, TV etc., can play an important role in educating the regarding environmental problems and issues.

Science Centres: Establishing science centres in villages and remote areas can be an effective way of spreading information about environmental problems, their causes and control measures.

Through organizing seminars and conferences: It may help in spreading environmental information to general public.

Natural Resources: The natural resources are the sources which are more essential for the functioning of organisms, human beings and ecosystem. Example: Water, air, soil, minerals, forests, crops and wild life etc. Natural resources are classified into three different types.

Classification of Natural Resources



Continuous resources are directly obtained from the environment without any interference. They can be renewed continuously. Example: Solar energy winds and tides.

Renewable resources are capable of being regenerated or replaced by ecological processes on a time scale relevant to their use. Example: Forests, grass lands, wild animals, fresh water, fresh air and fertile soil.

Non-Renewable resources fixed quantity or stock in the earth crust which cannot be regenerated by ecological process. Example: Energy resources (*i.e.*, fossil fuel like coal, oil, and natural gas etc.), metallic mineral resources (*i.e.*, iron, copper, aluminium etc.,) and non-metallic resources (salt, clay, sand, etc,).

FOREST RESOURCES

A biotic community which is predominantly composed of trees and other vegetation with a closed canopy is called forest.

Types of forests

1. Evergreen forests

Evergreen forests are generally found in the equatorial regions, where the temperature and rainfall is very high. Due to heavy rainfall throughout the year these forests are evergreen.

Example: The silent valley in Kerala.

2. Deciduous forests

These forests are of two types

a) **Tropical deciduous forests**: These forests are generally found in the tropical monsoon. As these forests receive only seasonal rainfall, they shed their leaves during the summer season.

b) **Temperature deciduous forests**: Due to severe winter with heavy snowfall the trees shed their leaves just before the winter season.

3. Coniferous forests: The snow slides down the sloping sides of the trees. The needle typed leaves preserve the moisture.

Uses or Benefits of forests

Commercial or economical uses:

- Industrial wood-timber(for furniture, tool-handles, doors, windows, boats and others), Fuel wood (for energy, purpose and cooling), bamboo (for matting, roping, flooring, cots and others)
- Food products like fruits, leaves, roots, tubers plants, flesh of animals and others.
- It provides the raw materials for paper and fibre industries.
- Forest also provide the variety of medicinal products, insecticides, gums etc.,

Ecological uses: The ecological services provided by our forests are as follows:

- **Production of oxygen**: The trees produce oxygen by photosynthesis which is so vital for our life on this earth. They are rightly called as earth's lungs.
- **Reducing global warming**: The main green house gas CO_2 is observed by the trees because it is a raw material for photosynthesis. Thus forest canopy acts as a sink for CO_2 thereby reducing the problem of global warning caused by carbon dioxide.
- **Conservation of Soil**: Forest prevents soil erosion by binding the soil with the network of roots of the different plant and reduces the velocity of wind and rain which are causing soil erosion.
- **Soil-improvement**: The fertility of the soil increases due to the humus which is formed by the decay of forest litter.
- **Reduction of Atmospheric Pollution**: By using up carbon dioxide and giving off oxygen during the process of photosynthesis of plants. So forests reduce the pollution and purify the environment.
- **Control of Climate**: Transpiration of plants increases the atmospheric humidity which increases the rainfall and cools the atmosphere.
- **Shelter:** Forest provides the shelter for masses, ferns, insects, birds, reptiles, mammals and micro-organism.

Over Exploitation of Forests:

Due to over population, the materials supplied by the forest like food, medicine, shelter, wood and fuel are not sufficient to meet the people's demand. Hence exploitation of forest materials is going on increasing day by day.

With growing civilization, the demand for raw materials like timber, pulp, minerals, fuel wood etc., increases resulting in larger scale logging, mining, road building and cleaning of forests.

Deforestation

The term "**deforestation**" refers to drastic elimination of forest resources due to many natural and man-made activities.

Causes of Deforestation

Population Explosion: Population explosion is a major reason for deforestation. Vast areas of forest land are cleared of trees to reclaim land for human settlements (factories, agriculture, housing, roads, railway tracks etc.). Growth of population increases the demand for forest products like timber, firewood, paper and other valuable products of industrial importance, all necessitating felling of trees.

Forest Fire: Fires in the forest may be due to natural calamities or human activities.

- On fire of the humus and organic matter forming a thick cover over the forest floor (Ground fires).
- Dried woods and leaves may catch fire (surface fires).
- In densely populated forests, trees tops may catch fire by heat produced by constant rubbing against each other (crown fires).
- Human activities like clearing forest for habitation, agriculture, firewood, construction of roads, railway tracks and carelessness (throwing burning cigarette Stubbs on dried foliage). Fire destroys fully grown trees, results in killing and roasting of the seeds, humus, ground flora and animal life.
- **Grazing Animal:** Trampling of the forest soil in the course of overgrazing by livestock has far reaching effects such as loss of porosity of soil, soil erosion and desertification of the previously fertile forest area.

Pest attack: Forest pests and insects destroy the trees by eating up the leaves boring into shoots and by spreading the diseases.

Natural forces: Floods, storms, snow, lightening etc. are the natural forces which damage forests.

Development of projects: Massive destruction of forests occurs for various development projects like hydroelectric projects, big dams, road construction, mining etc.

Major Consequences (Or) Effects of Deforestation:

1. **Global warming**: The cutting and burning of forest trees increases the CO_2 content in the atmosphere, which in turn changes the global climate pattern, rising sea levels and depletion of the protective ozone layer.
2. **Loss of genetic diversity**: The destruction of our forest destroys the greatest storehouse of genetic diversity on earth, which provides new food and medicines for the entire world.
3. **Soil erosion**: Increased soil erosion due to reduction of vegetation cover.
4. **Habitat destruction of wild animals**: Tree- using animals are deprived of food and shelter.
5. **Loss of food products**: As a result of soil erosion, forest areas loose the forest products
6. **Flood and Landslides**: Frequent floods, landslides in hilly areas and wind speed are heavy.

Preventive measures or avoid of deforestation or conservation Measures of Forest Resources:

There is an urgent need for bringing to halt the ecological degradation in the form of deforestation which leads to soil erosion, desertification and harmful climatic condition. The following measures should be taken to conserve the forest resources.

- Timber and fuel wood should be very economically by minimising wastage.
- Alternate sources of energy such as biogas, solar energy should be developed to supplement fuel wood.
- Overgrazing and deforestation should be prohibited. Reforestation of deforested areas should be encouraged.
- Pest and fire control by modern techniques should be adopted to prevent loses of forest.

- Forestry should be improved by modern techniques like are of fertilizers, irrigation, weed control, tissue-culture etc.

Timber Extraction, Mining, Dams and Their Effects on Forests and Tribal Peoples

Timber extraction: Timber is the major resource of a forest. Timber is required in large amounts due to various applications such as manufacturing of furniture, doors, window, sleepers in railway industry and boat industry. At present, the consumption of timber is drastically reduced due to the imposition of ban on cutting of valuable trees.

Effect of Timber Extraction:

- Large scale timber extraction leads to deforestation
- It leads to loses of biodiversity.
- Urbanisation and due to migration of tribal people
- Soil erosion and landslides
- Loses of tribal culture

Mining: Mining is the process of removing deposits of ores at the ground level or below the ground level. There are two types of mining.

1. Surface Mining
2. Underground mining.

1. Surface Mining: It is adopting for extraction of minerals or fossil fuel like coal from shallow deposits. It requires large amount of land area for its operation and management. During the course of mining or after the mining, forest resources are completely destroyed by clear-cutting of plants.

2. Underground Mining: It is adopting for extraction of minerals or fossil fuel from deep deposits. The extent of damage by underground mining to the forest resources is significantly lower than surface mining. But the cost of underground mining and risk involved is very higher than the surface mining.

Consequences (or) Effects of Mining

1. Surface Mining:

a) Surface mining leads to acid mine drainage which degrades the quality of water. Acid mine drainage mainly consists of sulphuric acid, iron compound, toxic soluble

substances, salts and sediments. So it acts as a source of acidity of natural waters. So it degrades aquatic habitats and can be fatal to aquatic life (especially fishes).

b) Surface mining strips the land of vegetation cover and results in soil erosion which causes deposits of sediments in channels. This reduces the capacity of streams to entry flood waters thereby flooding the nearby low lying areas.
c) Landslides are occurred also due to surface mining.
d) The machineries used for blasting operations in a surface mine pollute the environment with air-pollutants, dust and noise.

2. Underground Mining:

a) Underground mining also leads to acid mine drainage which causes water pollution.
b) Large land areas lying over unworked portions of the mine get destroyed by mining subsidence.
c) Large forest cover area occupied by dumping of mining wastages leads to deforestation.
d) Appearance of large cracks in many mined out areas leads to damage of road, railway tracks, river beds and buildings.
e) In case of delayed subsidence, sudden breakage of the strata (layer) is leads to dangerous problem to the workers.

Dams and Their effects on forests and Tribal People:

Dams are the massive artificial structures built across the river or stream to create a reservoir in order to store the rain water for future use.

Effects of Dams on forests:

a) Creation of reservoirs occupies the larger area of forest land.
b) Water logging and Salinity occurs in and around the dam area.
c) Several species of animals and plants have been pushed into threatened status by dams and associated impacts.
d) Spread of water borne diseases (Malaria)

Effects of Dams on Tribal:

a) Tribal were forced to leave their habitat because of the loss of biodiversity.
b) Rights to life of tribal in their biotic environment are guaranteed one and the dams diminish these rights.

c) The displacement and cultural change affects the tribal people both mentally and physically. They are not adapted to the modern food habits and life styles.

d) They are ill-treated by modern society beyond the protection of law and least considered in any forum.

WATER RESOURCES

Water is a marvellous substance and is a renewable resource. It is essential for all living organisms including plants, animals and man. 71% of the earth is covered by water. However, most of the world's water has little potential for human use because 97% of water on earth is saline water and remaining 3% is fresh water. Only 1% is in rivers, lakes and shallow aquifer are readily available for human kind.

Importance or use of water

a) Water cycle plays an important role in maintaining different forms of water in nature. Water passes into the atmosphere by evaporation from the surface of moist earth, lakes, streams, oceans etc. Water vapour gets condensed and returns to the earth in the form of rain and snow.

b) Water plays an important role for the manufacturing of essential commodities, generation of power, transportation and recreation in domestic, commercial, agricultural and industrial activities.

c) Water is a universal and cheap coolant.

d) All physiological activities of living beings are carried out in water environment.

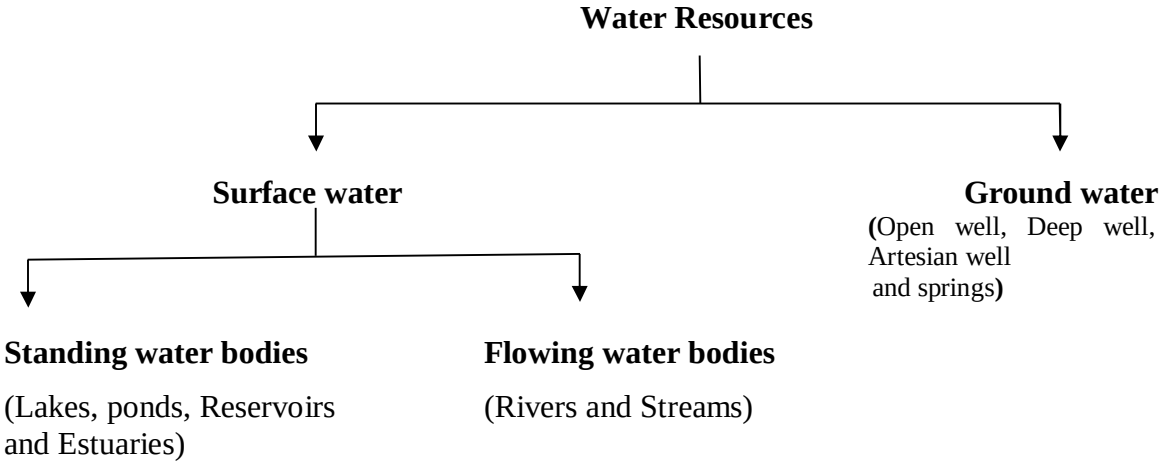
e) Water is the important components of photosynthesis in which solar energy is trapped for food.

f) All industrial processes require water for various purposes.

g) Water cleans the atmospheric air. Water vapour condenses around fine particles and gaseous material and entire load of waste is brought down with rain.

h) Water is used for domestic purposes such as drinking, cooking, bathing, washing of hands flushing of urinals, washing clothes, washing floors, and gardening, cleaning vehicles and maintaining domestic animals.

Types of water Resources



Effects of over - exploitation of Water Resources (or)

Over-utilization of surface and ground water

1. Lowering of water table: Heavily pumped well can lower the local water table which decreases the surface water level or dry them up completely with serious impacts on animal life and recreation.

2. **Ground subsidence**: Excessive pumping of ground water causes porous formation which leads to subsidence or setting of the above surface.

3. **Increasing the salt water**: The major effect of excessive pumping of ground water leads to salt water intrusion in coastal zones which upsetting the ecological balance in those important zones. Excessive irrigation is done with ground water which causes salt accumulation in the soil which reduces the crop productivity

4. **Drying up of well**: Over utilization of surface water resources (lakes, ponds, reservoirs and dams), resulting in drying up of nearby well and decreases the ground water level.

5. **Pollution of water**: Agricultural over exploitation of ground water affects the long term prospects for irrigated lands. The water containing the nitrogen as nitrate fertilizer percolates rapidly into the ground and pollutes the ground water.

6. **Earthquake and landslides**: Over-utilization of ground water leads to decrease in water level, which cause earthquake, landslides and famine.

7. **Surface water**: The surface water is largely used for irrigation, industrial use, public water supply, etc. the surface water level decreases.

Water Resource Problem or Water Calamities

Sometimes heavy rain fall leads to flood and lower rain fall lead to drought. So both flood and drought are usually called as natural disaster.

Floods:

Flood is the over of water which exceeds the carrying capacity of the Receiving River and stream system. It occurs due to heavy rain fall, melting of ice or snow and heavy tides.

Consequences of flood:

- Vegetation is removed due to rapid water flow over the surface into streams.
- Increases the soil erosion
- Carries fertile sediment towards the lower areas.
- Loss of materials and life.
- Reduces the capacity of rivers or streams by filling various sediments.

Control measures:

- Proper watershed managements, control soil erosion and reduce surface run off.
- Build more dams to store the flood water coming from the properly managed watersheds.
- Design cities and town to retain more water and release it more slowly following rain fail.

Drought: Drought is defined as when annual rainfall is below normal and less than evaporation, drought conditions are created. Drought may be defined as an extended period (a reason, a year, and several years) of deficient rain fall relative to the statistical multi-year average for the region. It leads to insufficient water supply for plants, animals and human beings.

Consequences (or) effects of Drought:

1. **Desertification:** The process of forming useless dry land which is less capable of retaining vegetation and progressing towards desert land is known as desertification.
2. It leads to food insecurity, malnutrition, epidemics and displacement of populations from one area to another.
3. Absences of rain causes dry weather even in areas of moist air.
4. Localized subsidence induced by mountain barriers or other physiographic features. This allows to hold the moisture and carry it way.
5. **Famine:** Famine is a catastrophic food shortage affecting large numbers of people due to climatic, environmental and socioeconomic reasons. Famine causes migration of people from one area to another area.

Drought Management

- ✓ Water conservation
- ✓ Sustainable use of water
- ✓ Water cycling
- ✓ Afforestation
- ✓ Use alternate technologies (drip irrigation).

Conflicts over water: It means that difference in opinion arises with in state level, National level and International level.

The existing constitutional provisions and legislations in India do not provide an appropriate framework to deal with water sharing issues between the states, sectors and individuals. In present setup,

a. Primary powers are vested at state levels which do not correspond to river basin boundaries.
b. Surface water rights are not clearly defined and such rights cannot be commercially transferred.
c. Ground water rights are purely private

Some of the existing conflicts between states related to the sharing of water of rivers that flow through more than one state are

a. Sharing of the water of river Krishna between the states of Maharashtra, Karnataka and Andhra Pradesh.

b. Sharing of the water of river Cauvery between the states to Tamilnadu and Karnataka.
c. Sharing of Siruveni water between Tamilnadu and Kerala.

Dams – Benefits and Problems:

Dam is an artificial structure made up of either stone or brick masonry constructed across the rivers or stream. It is used to store the rain water for future use.

Benefits: Some of the important applications of Dams are as follows:

a) Dams are constructed to create a reservoir to store the rain water.
b) Dams are also used to diverting part of the entire river into a channel.
c) It is used for recreational purposes.
d) It is used for irrigation purposes
e) It is used to control the floods from the rivers.
f) It is morally recharge the ground water.
g) It is used to generate hydroelectric power thus reducing the cost of power generation from other sources.

Problems:

- ✓ Displacement of tribal people
- ✓ Loss of forests, flora and fauna
- ✓ Loss of non-forest land
- ✓ Growth of aquatic weeds
- ✓ Microclimatic changes
- ✓ Water logging and salinity due to over irrigation
- ✓ Reduced water flow and silt deposition in river
- ✓ Breeding of vectors and spread of vector-borne diseases.

Environmental Problems or disadvantages of water resource:

Some of the major environmental impacts are as follows:

a) Many towns, villages and good cultivation lands have been starved by huge dams and diversions.
b) The natural course of river has been affected which resulting the loss of fish and good cultivation land.

c) It promotes agricultural practice which leads to deforestation. Hence the ecology is disturbed.
d) Exceptional flood can exceed the capacity of reservoirs or can destroy the dams which lead to dangerous effects.
e) Water quality is degraded due to exposure of sun light directly on the dam water which leads to evaporation of water. It increases the salinity and makes the dam water not suitable for drinking and irrigation purpose.
f) The transport of sediments along the river water is disrupted. So there is an accumulation of toxic materials and build-up of sedimentation which reduces the capacity of reservoir.
g) Loss of land fertility along the river since the sediments carrying nutrients get deposited in the reservoir.
h) Several species of animals and plants have been pushed into threatened status by dams and associated impact.
i) It also changes the microclimate, loss of vegetal cover, soil erosion, and variation in water table and enhanced seismic activities due to pressure of water.

Sustainable Water Management: These include measures such as

- ✓ Soil management, micro-catchment development and afforestation permits recharging of underground aquifers, thus reducing the need for large dams.
- ✓ Building several small reservoirs instead of few mega projects
- ✓ Developing small catchment dams and protecting wetland
- ✓ Treating and recycling municipal waste water for agriculture use
- ✓ Preventing leakages from dams and canals
- ✓ Effective rainwater harvesting in urban environments
- ✓ Water conservation measures in agriculture, such as using drip irrigation.

MINERAL RESOURCES

A mineral is pure inorganic substances that occur naturally in the earth's crust having a definite composition, characteristics and physical properties. Some mineral are obtained as a single element such as gold, silver and diamond (carbon). Some mineral are identified in the combined form which are formed by the combination of various elements such as O, Si, Al, Fe, Ca, Na, K and Mg. Mineral resources are non-renewable

which include metals (iron, copper, aluminium, etc.) and non-metals salt (gypsum, clay, sand, phosphates, etc.).

Uses and Over exploitation

Minerals are used in domestic, agricultural industrial and commercial sectors. Thus it acts as a very important role of any nation's economy. The main uses of minerals are as follows:

1. Development of industrial plants and machinery
2. Generation of energy e.g. coal, lignite, uranium.
3. Construction of housing, colony, industries, etc.
4. Defence equipments – weapons, armaments (military equipments)
5. Transportation
6. Communication – telephone wire, cables, electronic devices, etc.
7. Medicinal system – Particularly in Ayurvedic system.
8. Formation of alloys for various purposes (phosphorite)
9. Agriculture – As fertilizers, seed dressings and fungicides (e.g.-Zineb containing zinc, Maneb – containing manganese).
10. Jewellery – e.g. Gold, silver, platinum, diamond.

Mineral resource in India

India has large number of economically useful minerals and they constitute one – quarter of the world's known mineral resources. They are as follows:

a) Energy generating minerals
   - Coal and lignite: West Bengal, Jharkand, Orissa, MP, AP, Tamil Nadu.
   - Uranium (Pitcheblende or uranite ore): Jharkand, A.P Nellore, Nalgonda), Meghalaya, Rajasthan(Ajmer)

b) Commercially used minerals

- Aluminium (Bauxite ore): Jharkand, M.P, West Bengal, Maharashtra, Tamil Nadu.
- Iron (Haematite and magnetite ore): Jharkand, Orissa, M.P, A.P, Tamil Nadu, Karnataka, Maharashtra and Goa.
- Copper (Copper pyrite): Rajasthan (Khetri), Bihar (Singhbum), A.P, (Agnigandala) and parts of Sikkim and Karnataka.

- Gold mines: Ramagiri, (A.P), Kolar and Hutti in Karnadaka.

Mineral Exploration and Extraction:

Mineral exploration is the identification of mineral resources in the earth crust. Mineral exploration in India is carried out by MECL (Mineral Exploration Corporation Limited). Its activities include: mineral targeting, mineral deposit assessment and mine development.

Ministry of Mines established the international Cooperation cell. The major objectives of this cell is introduction of modern technologies for exploration of minerals, improved resources recovery, better operational practices, improvement of productivity and conservation of minerals and energy.

Minerals extraction is divided into three basic methods: Mineral extraction is the separation of minerals from the earth crust. Various extraction methods are as follows:

a) **OPEN CAST MINING:** when a mineral is situated close to the surface, the soil and the overlying layers are removed and the minerals are taken out. This is economically cheapest method. It is also called surface mining.

b) **QUARRYING:** When the mineral is present at the surface, it can be simply taken out or blasted out with explosives. Building and road stone is extracted in this method.

c) **UNDERGROUND MINING:** It is the extraction of minerals below the earth's surface. This method is highly risk as compared to open cast mining.

ENVIRONMENTAL EFFECTS ON MINERAL EXTRACTION:

The environmental impact or effects caused by mining activities are as follows:

- **Devegetation and defacing of landscape:** The top soil as well as the vegetation is removed from the mining area to access the deposit. While large scale deforestation leads to several ecological losses. Large mining operations disturb the land by directly removing material in some areas and dumping waste in other area. It leads to soil erosion.
- **Subsidence of land:** Subsidence of mining areas often results in tilling of buildings, cracks in houses, blocking of roads, bending of rail tracks and leaking of gas from cracked pipe lines leading to serious disasters.

- **Ground water contamination:** In many ores having sulphur as impurities. This sulphur is converted into sulphuric acid through microbial action which making the water as acidic. During the mining operation, ground water is completely removed off which decreases the ground water level.
- **Surface water contamination:** Suppose the acid mine drainage is contaminated with nearby streams or lakes which causes dangerous effects to many form of aquatic life. Some heavy metals also contaminate the water bodies through mine wastes and kill aquatic animals.
- **Air Pollution:** In mining, huge volumes of dust generated by explosions, transportation and processing lead to the death of surrounding vegetation. Emission of toxic gases, including CO, H_2O, SO_2 and nitrous oxide, leads to serious health problem for local residents.
- Blasting and transport cause noise disturbance to local residents and wildlife.
- Extraction and transportation requires huge amounts of energy which leads to acid rain and global warning.

Conservation of mineral Resources:

- Search for new mineral deposit.
- Application of efficient methods of mining to takeout every possible tonnage lying underground.
- Environmental impact can be minimized by adopt eco-friendly mining technology.
- Use, reuse and re-cycling of the metals.
- Recovering all associated elements as co-product or by products
- Economic use of minerals
- The low-grade ores can be better utilized by using microbial-leaching techniques.

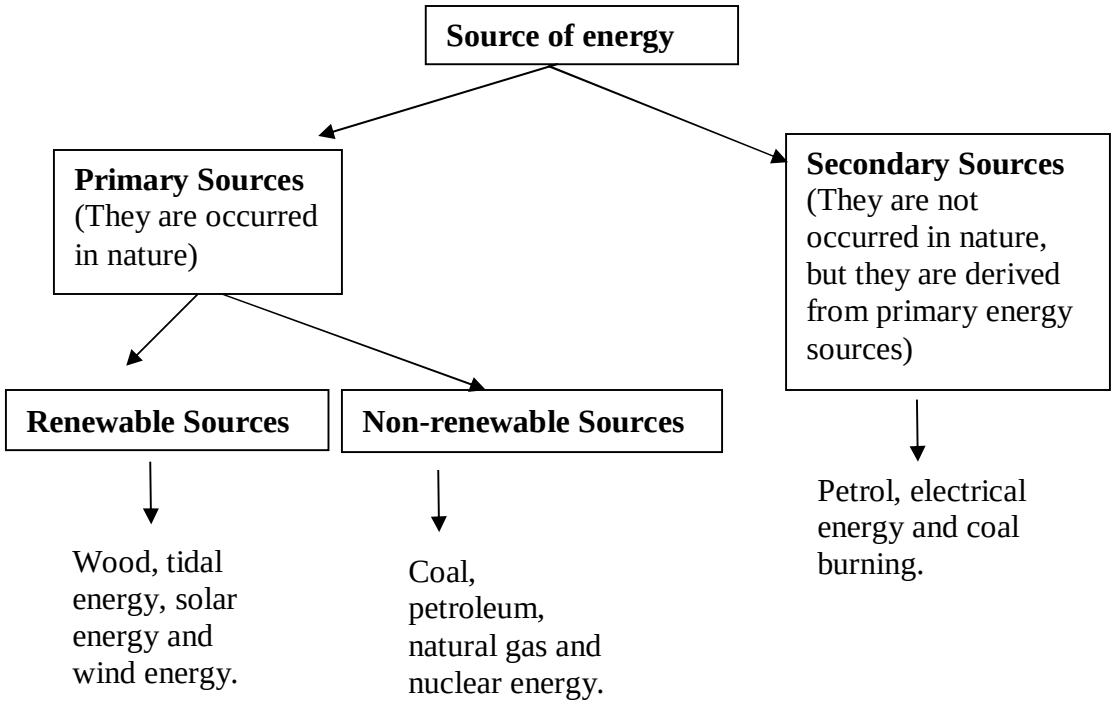
ENERGY RESOURCES

Energy is defined as the capacity to do work. Energy is found on our planet in a variety of forms. Some of which are immediately useful while other require a process of transformation.

The source from which the energy can be extracted and utilized over a long period of time by mankind is called energy sources. These energy resources can be classified into two types.

1. Renewable Resources: It can be generated continuously in nature and are in exhaustible. They are also known as non-conventional sources of energy and they can be used again and again in an endless manner. **Example:** Wood, Solar Energy, Wind Energy, Tidal Energy, Hydropower, Biomass Energy, Bio-Fuel and Hydrogen Energy.

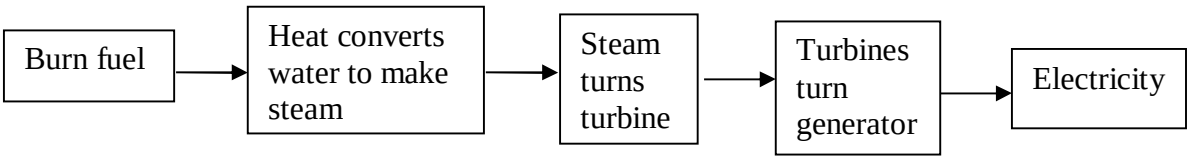
2) Non-renewable resources: It has accumulated in nature over a long span of time and cannot be quickly renewed when exhausted. **Example:** Coal, petroleum, natural gas and nuclear fuels like uranium and thorium.



Non-renewable resources:

These are the fossil fuels like coal, petroleum, natural gas and nuclear fuels. These were formed by the decomposition of plants and animals buried under the earth before millions of years ago. These fuels are very precious because they have taken such a long time for their formation and if it is exhausted by us then very soon we will lose these resources forever.

1. Fossil fuels: Coal, oil and gas are examples of fossil fuels. They are organic fuel resources found in earth's crust, which have been formed by the effect of heat and compression on forest and other organic matter buried under the earth. Coal is converted in to fine dust and burnt. Oil and gas burn directly. They are used for the production of electric power. They are represented as follows:



Advantages:

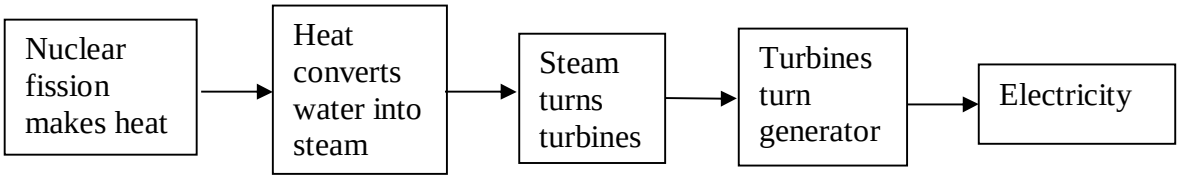
1. Transporting oil and gas to the power stations is easy.
2. Gas fired power stations are very efficient.
3. Very large amount of electricity can be generated in one place using coal which is fairly cheap.

Disadvantages:

1. Basically, the main drawback of fossil fuel is pollution. It produces CO_2, Which contributes to the "green house effect" which warming the earth.
2. Mining coal is difficult and dangerous.

Nuclear energy:

Nuclear power is generated by using Uranium. Nuclear power produces around 11% of the world's energy needs and produces very high energy from small amount of fuel. Electricity is produced as per the following flow diagram:



a) Nuclear power stations are very much similar to fossil fuel power stations, except that a "chain reaction" inside a nuclear reactor makes the heat instead.

b) The reactor uses Uranium as fuel and the heat is generated by nuclear fission reaction.

c) CO_2, H_2O or heavy water is pumped through the reactor to take the heat away and the heat is used to make steam.

d) The steam drives turbines with generators.

Advantages:

1. It produces huge amount of energy from small amount of fuel.
2. Produces small amount of waste.
3. Nuclear power is reliable.

Disadvantages:

1. The waste produced by nuclear reactor is very dangerous.
2. Large amount of money has to be spent on safety aspects.

Renewable Energy Resources or Non-Commercial or Non-Conventional Resources:

This energy, replacing fossil fuel generated electricity supplied to India's cities with energy from renewable energy sources could aid in reducing air pollution.

1. **Solar energy:** Sun is the ultimate source of energy directly or indirectly for all other forms of energy. The nuclear fusion reaction occurring inside the sun release enormous quantities of energy in the form of heat and light. Traditionally, solar energy is used for drying clothes, food grain, preservation of eatables and for obtaining salt from sea-water. Now several techniques are available for harvesting of solar energy. Some important solar devices are as follows:
   a. **Solar Cells:** (photovoltaic cells) Solar cells are made of thin cover of semiconductor materials like silicon and gallium when solar radiations falls on them, a potential difference is produced in between two semiconductors. This causes flow of electrons and produce electricity. The structure of the solar cell is as follows.

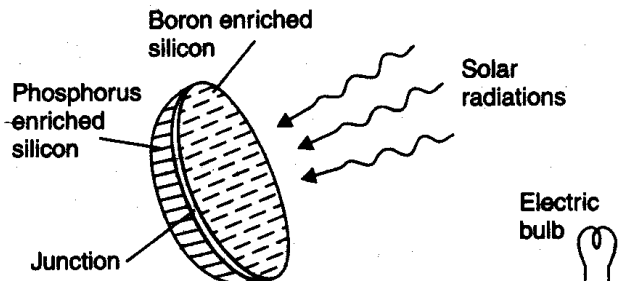


Fig. 1.4. Solar Cell

b. **Solar Furnace:** Here thousands of small plane mirrors are arranged in concave reflectors, all of which collect the solar heat and produce high temperature at 3000^0C.

c. **Solar Power Plant:** By using reflectors, water is converted into steam. The steam turbine drives a generator to produce electricity (Gurgam at Haryana having 50K Watt capacity).

Advantages:

1. Solar energy is freely available. It needs no fuel and produces no waste or pollution.
2. Solar power can be used where there is no easy way to get electricity to a remote area.

Disadvantages:

1. Does not work at night.
2. Very expensive to build solar power stations.
3. During the times of clouds, this type of energy is unreliable.

Wind Energy: The high speed winds have a lot of kinetic energy due to their motion. The driving force of the winds is received from the sun. The wind energy is saved by using wind mills. The blades of the wind mill keep on rotating continuously due to the force of the striking wind which turns a generator to produce electricity. The wind power potential of our country at present is 1020 MW. The largest number of wind mills of our country is near kanyakumari in Tamil nadu generating 380 MW electricity. The structure of the wind mills is shown in figure 1.5.

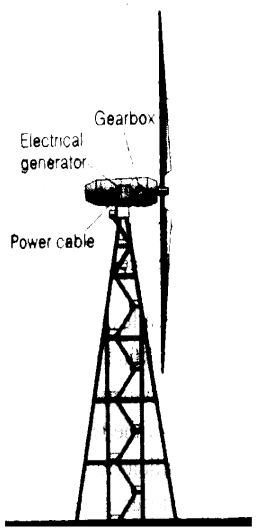


Fig. 1.5. Wind Mills

Advantages:

1. Wind is freely available and needs no fuel
2. It produces no waste.
3. The land beneath can be used for farming
4. A good method of supplying energy to remote area.

Disadvantages:

1. The direction of the wind is not predictable sometimes have no wind.
2. Suitable areas from wind farms are often near the coast, where land is expensive.
3. Can affect Television reception if one lives nearly.

Hydropower: The water following in a river is collected by constructing a big dam where the water is stored and allowed to fall from a height. The blades of the turbine located at the bottom of the dam move with the fast moving water which in turn rotates the generator and produces electricity. The hydropower is converted by using water energy is shown in figure 1.6.

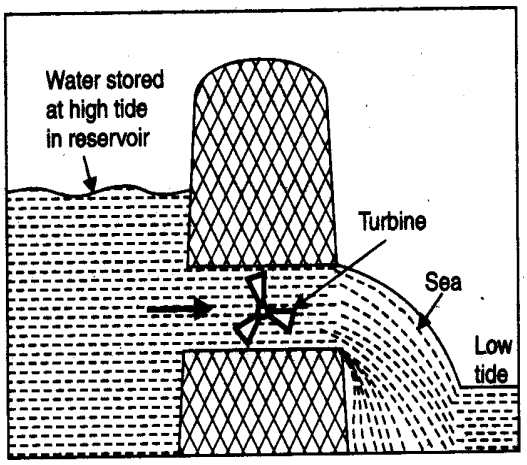


Fig.1.6. Hydroelectric power Generation

Advantages:

1. It is renewable and has low running costs.
2. Hydro power projects are multi-purpose projects helping in controlling flood, used for irrigation, navigation etc.

Disadvantages:

1. Dam have constructed in longer surface which affects the wildlife sanitary forests, agricultural lands etc., Especially tribal and formers are highly affected.
2. Some dames create health problems to the local resident
3. Out flow of water from the dam causes soil erosion.
4. It is suspected that large dams cause earthquakes

Tidal energy: The source of energy related to local geological conditions is tidal flow. The gravitational pull of the sun and moon along with the earth's rotation causes tides. The tidal movement of water have large amount of energy. This moving water could be used to produce electricity. The water flows from a higher level to a lower level, the blades of the turbine are rotated by the striking force of water which is turn rotate the generator and produces electricity.

Ocean Thermal Energy: The oceans collect and store huge quantities of solar radiation in the form of heat. The temperature on the sea surface is higher than the temperature of the deep water. Using this temperature difference, which is in the order of 20^0C, it is theoretically possible to convert the heat into electricity. Many low boiling liquids like

ammonia, Freon, butanes etc., can be used for extracting the heat and converting it into electricity with a theoretical efficiency of 1 to 3 percent.

Geothermal energy: The Core of the earth is very hot and it is possible to make use of this. The earth's core have molten mars of material (at 60,000^{o}C) which processing vast amounts of geothermal energy. In some regions, this material breaks through the earth and produces volcanoes. In other regions, the hot materials are close enough to underground water and convert it into steam. In this area, geothermal energy is tapped by drilling wells to obtain the steams and it is used to produce electricity through generator. The main source this energy is the radioactive decay of Uranium and thorium.

Biomass Energy: Biomass is an organic material which has stored in the form of chemical energy. Biomass fuels include wood, wood waste, straw, manure, sugar cane and many others by products from a variety of agricultural processes. Biomass energy is divided into following types:

Energy Plantation: Solar energy is trapped by green plants through photosynthesis and converted into biomass energy. In the process of photosynthesis, plant converts solar energy into chemical energy in the form of glucose or sugar.

$$\text{Water + Carbondioxide + Sunlight} \xrightarrow{\textit{Chlorophyll}} \text{Glucose + Oxygen}$$

$$6H_2O + 6CO_2 + \text{radiant energy} \rightarrow C_6H_{12}O_6 + 6O_2.$$

By photosynthesis, solar energy can be converted into biomass which can be stored and used as fuel in various forms

Petro Crop: Latex containing plants like Euphorbias and oil plants which are rich in hydrocarbons and can yield oil like substance under high temperature and pressure. This oily material may be burned in diesel engines directly or may be refined to form gasoline. These plants are popularly known as petro – crop.

Agricultural waste Biomass: Crop residues, Sugar cane residues, coconut stalks, peanut hulb, cotton stalks etc., are some of the common agricultural wastes which produces energy by burning. In rural India, animal dung cakes are burnt to produce heat. About 80% of rural heat energy requirements are met by burning agricultural wastes, wood and animal dung cakes. The burning of plant residues or animal waste cause air pollution and

produce a lot of ash as waste residue. The burning of dung destroys essential nutrients like N and P. So, it is more useful to convert the biomass into biogas or bio-fuels.

Technologies for the conversion of Biomass energy into alternative Energy: At present, biogas technology provides an alternative source of energy in rural India for cooking. It is useful for village households that have their own cattle. Through a simple process cattle dung is used to produce a gas, which serves as fuel for cooking. The residual dung is used as manure. Biogas plants have been set up in many areas and are becoming very popular. Biogas is prepared by using local resources (cattle waste and other organic wastes). A mini- biogas digester has recently been designed and developed and is being in- field tested for domestic lighting and cooking. The structure of the fixed dome type Bio gas plant is shown in figure 1.7.

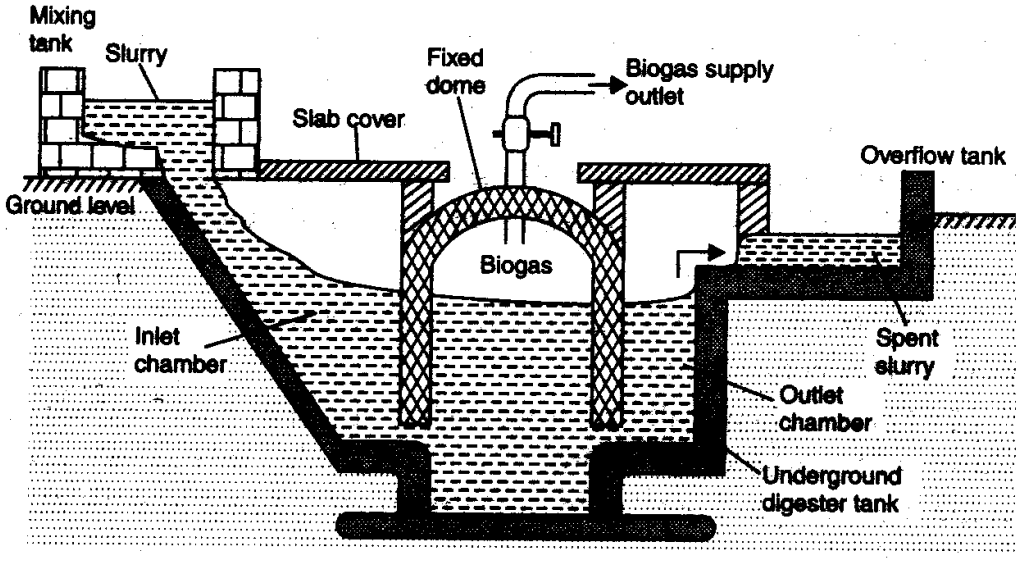


Fig. 1.7. The structure of the fixed dome type Bio gas plant

A biogas sample has 68% methane, 31% CO_2 and 1% N_2 and gives calorific value 5871 Kcal/m^3. Biogas is produced by anaerobic degradation of animal waste in the presence of water. Anaerobic degradation means break down of organic matter by methanobacterium and *methanococcus sp.* in the absence of oxygen. Biogas is a non-polluting, clean and low cost fuel which is very useful for rural areas, where a lot of animal waste and agricultural waste are available.

LAND RESOURCES

Land is the biggest renewable resource of a biotic community to reproduce, sustain, grow, exploit and any life supporting activities. This resource helps us in many ways: i) keeping effective Biodiversity, ii) Food production, iii) Mineral deposits and ground water, iv) Wetlands v) Irrigation potential, vi) Infrastructure development like houses, buildings, airports, dams and reservoir, vii) Industrial production and viii) Biogeochemical cycle waste distribution and disposal.

If forests are depleted or grasslands are overgrazed, the land becomes unproductive and wasteland is formed. Intensive irrigation leads to water logging and salinisation which reduces the crops productivity. Land is also converted into a non-renewable resource due to dumping of toxic industrial and nuclear wastes.

Land Degradation:

Land degradation is defined as any change in the land that reduces its quality and productivity. It occurs due to human activities on landscape. With increasing population growth demands for cultivation land, producing food, fibre and fuel wood is also increases. Hence there is more and more pressure on the limited land resources which gets degraded due to over exploitation.

Causes of land degradation are soil erosion, desertification, water logging, salinity and contamination of the soil with industrial wastes (fly-ash, press-mud or heavy metals) and nuclear solid wastes.

Soil erosion or degradation:

Soil erosion is refers to the removal of top soil from its resting place by various physical agencies such as wing and water.

Causes of soil erosion

- ✓ Deforestation
- ✓ Floods in rivers: Floods accelerate soil erosion due to the rapid flow of water along slopes, run off, etc., which washes away fertile soils along with it.
- ✓ Overgrazing by cattle

- ✓ Dry violent winds: Soil particles are taken away along with wind leading to soil erosion.

Effects of soil erosion

- ✓ Decrease in productivity of land
- ✓ Desertification of land
- ✓ Deposition of soil in water bodies.

Methods to control of soil erosion

- ✓ Increases forestation on barren land
- ✓ Control of overgrazing
- ✓ Construction of small check dams
- ✓ Promoting equitable use of water resources.

Desertification:

Desertification is the progressive destruction or degradation of existing vegetation cover from the land surface to form desert. (Or) **conversion of fertile land into infertile land is called desertification.**

Causes of Desertification:

- ✓ Overgrazing
- ✓ Mining, quarrying, deforestation, drought, flood and the burning of trees in extensive areas.
- ✓ Continuous cutting of trees
- ✓ Excessive plugging: Excessive plugging makes the soil particles loose and lead to desertification.
- ✓

Impact of desertification:

1. Increase in surface run off and stream discharge
2. Reduction of water infiltration and ground water recharge
3. Development of soil erosion
4. Reduction of soil fertility and biological productivity.

Control of Desertification

- ✓ Promoting large scale plantation of trees.
- ✓ Development of water-catchment areas.
- ✓ Development of pasture lands and control of overgrazing.
- ✓ Promoting equitable use of water resources.

Land Slides:

Land sliding is the process of large differential movement of two land portions. Both natural and man-made activities are responsible for land sliding. Various man-made activities like construction of hydroelectric projects, large dams, reservoirs, roads and railway lines are responsible for landslides.

Cause of Landslides:

1. Over exploitation of groundwater.
2. Improper mining operation and its abandonment
3. Construction of dams on faulty plans
4. Improper border road slopes
5. Improper construction of small hydropower plants in hilly regions
6. Tunnelling for transport and water ways.
7. Large scale disposal of hazardous waste.

Impact of landslides: The environmental effects of land slides are as follows.

1. Loss of habitat and biodiversity
2. Large scale destruction of vegetation
3. Destruction of communication links
4. Loss of infrastructure and economy

Water logging: Water logging is a process in which the ground water level is increasing too close to the ground level. When a soil is water logged pore space of soil is filled with water.

Reason for water logging:

- Period of heavy rain
- Poor irrigation management
- Poor drainage
- Over-watering with irrigation causes water logging
- Compacted soil

Consequence or Environmental Effect of Water Logging

1. Water-logged soil pores have no oxygen. Plants need oxygen to breath and grow.
2. Vegetation can turn yellow, growth is stunted and thin.

3. Trees and plants can die.
4. Bare patches of soil appear.
5. The contaminated soils with organic matter give bad odour due to anaerobic decomposition.
6. The salt concentration increases thereby increasing the salinity of soil.

Prevention of water logging:

i) Management of drainage lines for efficient water flow

ii) Management of surface water flow to avoid surface ponding

iii) Increase the deep rooting vegetation for greater utilization of water from the soil.

iv) Only apply water whenever it is necessary (e.g. when plants have used all available water for growth).

v) Apply only as much as the plant will use.

Salinity: Salinity is defined as the excessive accumulation of ionic species like Na^+, $Ca^{2+,}$ Mg^{2+}, K^+, Cl^-, SO_4^{2-}, PO_4^{2-}, NO_3^-, and others. The major reason for salinity is flooding and water logging. However, heavier application of synthetic fertilizers and land application of sewage and industrial effluents also affect salinity of soil. Some of the effects are as follows:

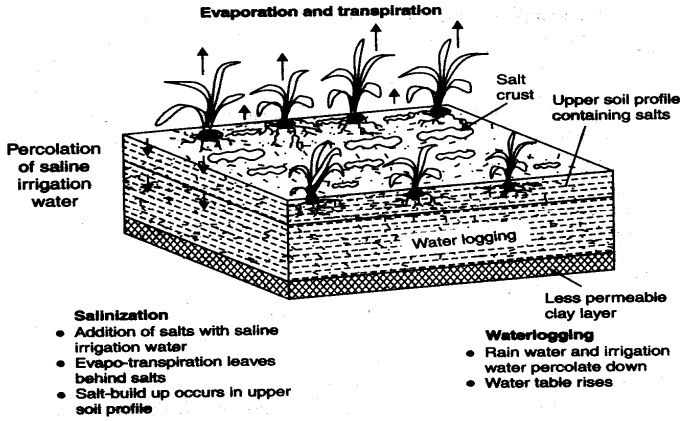
i) Ground water pollution, due to increase in total dissolved solids.

ii) Poor growth of plants in saline soils.

iii) Crop productivity is affected year-by-year.

iv) Decomposers and detritus food chain in soil is greatly affected and does not support the symbiotic action in root zone.

Fig. 1.3. Salinisation and water logging



Management of salinity: Some of the remedial measures of soil salinity are as follows:

i) Elimination of possible water logging areas by improving land drainage.

ii) Reduce the use of synthetic fertilizers.

iii) Exploiting the salt problems to grow specialised plant species which requires light salt.

iv) Effective recharging of soil for longer periods which is used to reduce salt content of the soil.

v) Installing underground drainage system.

Role of an Individual in Conservation of Natural Resources: Education is an important tool in reducing our impact on environment with new challenges in energy and water use, resource conservation education is playing an important role in creating individual awareness. Individual must understand the significance of natural resources. Natural Resources must be preserved and utilizing optimally. Resources such as oceans, forests, grasslands and wetlands are degraded by over use or may be destroyed. Because of over use, even biological resources traditionally classified as renewable becomes non renewable. Some of the roles of individual in the conservation of natural resources are as follows:

1. Preserving Biodiversity and protecting the Soil:

- Plant trees on a regular basis and take care of them.
- Reduce the use of wood and paper products.
- Restore a degraded one of forest near your home.
- Refuse to buy ivory products, items made of reptile skin, tortoise shell jewellery, and material from endangered animal species.
- When building a home, save all the trees as for as possible.

2. Saving energy and reducing outdoor air pollution:

- Reduce use of fossil fuels which reduce emissions of CO_2 and other air pollutants.

- Plant and care for trees to help absorb CO_2. During its lifetime the average tree absorbs enough CO_2 to offset the amount produced by driving a car 42,000 kilometres.
- Don't use electricity to heat space or water.
- Obtain as much heat and cooling as possible from natural sources especially sun, wind, geothermal energy, and trees.
- Lower the cooling load on an air conditioner by increasing the thermostat setting, installing energy-efficient lighting, Reduce floor and ceiling fans, and using whole house window or attic fans to bring in outside air (especially at night, when temperature are cooler).

3. Reducing exposure to Indoor air pollutants:

- Don't buy furniture and other products containing formaldehyde, and the use "low-emitting formaldehyde" or non-formaldehyde building materials.
- Reduce indoor levels of formaldehyde and other toxic gases by growing certain house plants. Examples are the spider or airplane plant (removes 96% of formaldehyde), banana (89 % of formaldehyde).
- Remove your shoes before entering your house. This reduces inputs of particles of dust, dangerous pathogenic organisms and pesticides.

4. Saving water:

- For existing toilets, reduce the amount of water used per flush by putting into each tank a tall plastic container weighted with a few stones,
- Install water-saving toilets that use no more than 6 litres (1.6 gallons) per flush.
- Check frequently for water leaks in toilets and pipes, and repair them promptly.
- When washing many dishes by hand, don't let the faucet run. Instead, use one filled dishpan or sink for washing and another for rinsing.
- Keep one or more large bottles of water in the refrigerator rather than running water from the tap until it gets cold enough for drinking.
- Reduce evaporation losses by watering lawns and gardens in the early morning or evening, rather than in the heat of midday or when it's windy.

- Use drip irrigation and much for gardens and flower beds. Better yet, landscape with native plants adapted to local average annual precipitation so that watering is unnecessary.

5. Reducing water pollution:

- Use manure or compost instead of commercial inorganic fertilizers to fertilize garden and yard plants.
- Use biological methods or integrated pest management to control garden, yard, and household pets.
- Use low-phosphate, phosphate-free, or biodegradable dishwashing liquid, laundry detergent and shampoo.
- Don't use water fresheners in toilets.
- Use pour pesticides, paints, solvents, oil, antifreeze, or other products containing harmful chemicals down the drain or on the ground. Contact your local health department about disposal.

6. Reducing solid waste and hazardous waste:

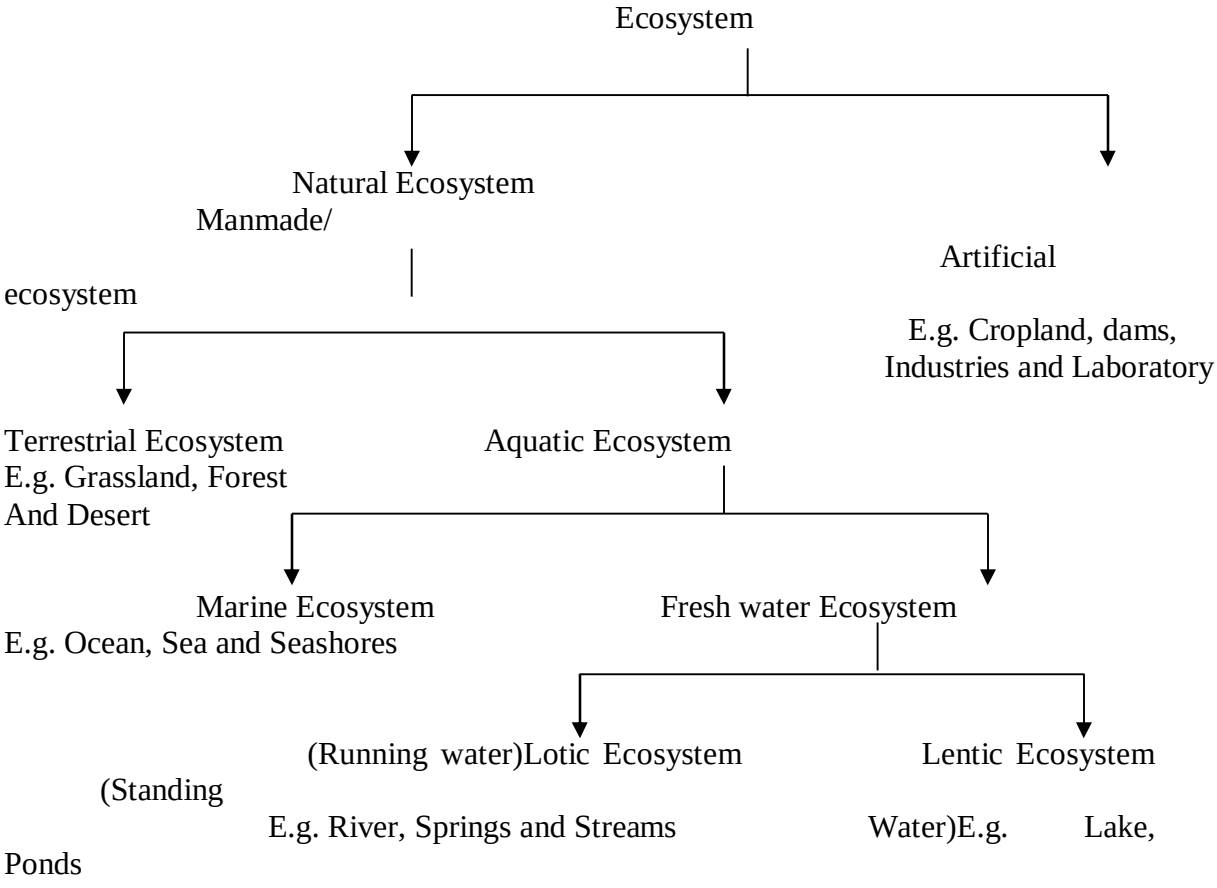
- Buy things that are reusable, recyclable, or compactable, and be sure to reuse, recycle, and compost them.
- Buy beverages in refillable glass containers instead of cans or throwaway bottles, and urge companies and legislators to make refillable plastic (PET) bottles available in the United States.
- Use reusable plastic or metal lunch boxes and metal or plastic garbage containers without throwaway plastic liners (unless such liners are required for garbage collection).
- Carry sandwiches and store food in the refrigerator in reusable containers instead of wrapping them in aluminium foil or plastic wrap.
- Use sponges and washable cloth napkins, dish towels, and handkerchiefs instead of paper ones.
- Use pesticides and other hazardous chemicals.
- Use less hazardous cleaning products.
- Don't dispose of hazardous chemicals by flushing them down the toilet.

UNIT II

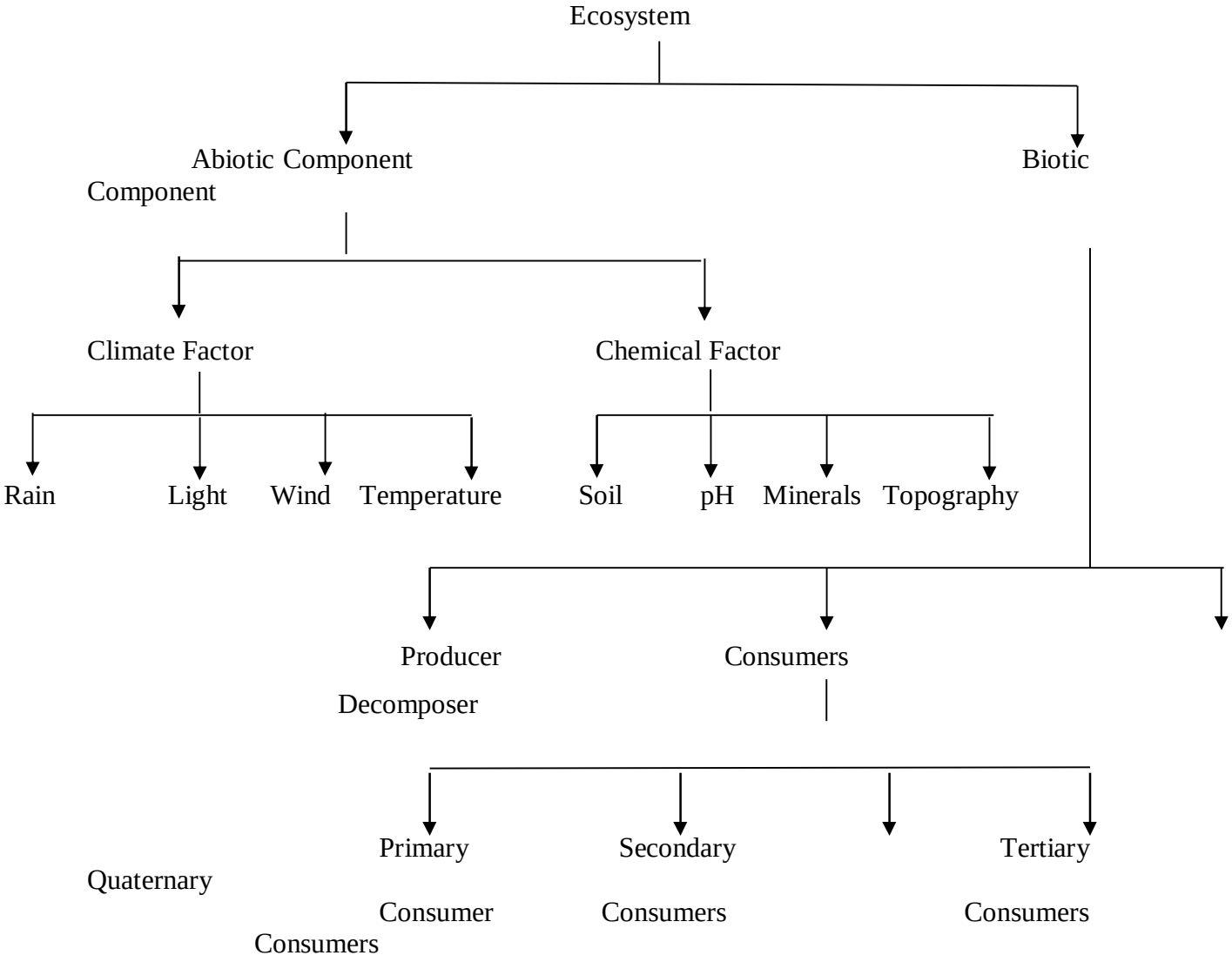
ECOSYSTEM AND BIODIVERSITY

Introduction: The term 'eco' means environment. The immediate surroundings of the living organism are the environment. Environment consists of both biotic and abiotic factors. These factors interact with each other and form the different types of ecosystem. So, Ecology is the study of inter-relationship between the biotic and abiotic components.

Ecosystem: Ecosystem means "study of home" which implies there is an interaction between a biotic community and its environment to produce a stable system called ecosystem. ***"An ecosystem is a natural, functional and ecological unit comprising of living organisms (biotic community) and their non-living (abiotic components) environment that interact with each other to form a stable self-supporting system".*** A pond, lake, desert, grass land, forest, marine etc. are common examples of ecosystems. On the basis of environment or habitat, ecosystem has been divided into the following types:



Structural and Functional Attributes of an Ecosystem: Structure of ecosystem has two main components: i) Abiotic components and Biotic components. They are discussed as follows:



1. **Abiotic components:** The physical and chemical environment of an ecosystem constitutes its abiotic components. They have a strong influence on the structure, distribution of energy, nutrients and toxic substances, behaviour and interrelationship of organism. Abiotic components are mainly consists of two factors which are highly influence the functioning of the ecosystems. They are as follows:
   a. **Climatic factors:** It includes rain, temperature, light, wind, humidity, solar energy, snow, etc.

b. **Chemical factors:** It include soil, pH, essential nutrients like carbon, nitrogen, phosphorus, potassium, hydrogen, oxygen and sulphur, toxic substances, various organic substances present in the soil etc.

2. **Biotic components:** The living organisms of ecosystem are known as biotic component which include plants, animals and microorganisms (bacteria, fungi etc.).

Type of Biotic components

The biotic components can be classified into three main groups on the basis of their role in the ecosystem. I) Producers, ii) consumers and iii) Decomposers or reducers. They are discussed hereunder:

Producers: Producers are the only biotic component which can manufacture their own food by trapping energy from the sun with the help of simple inorganic compounds CO_2 and water.

$$H_2O + CO_2 \xrightarrow[\text{Chlorophyll}]{\text{Sun light}} O_2 + \text{Food}$$

The chemical energy stored by the producer is utilized partly by itself for their own growth and survival. The remaining is stored in the plants parts for their future use. They are nothing but green plants. They are also called as autotrophs. (auto = self; trophs = feeders).

Consumers: Consumers are heterotrophic organisms. They cannot prepare their own food and depends directly or indirectly on the producers. The consumers are classified into four types which are as follows:

a. **Primary consumers or first order consumers:** There are the animals which directly depend on the plants or the producer for their food. They are also called as herbivores. E.g. rabbit, deer, goat cattle, etc.

b. **Secondary consumers or second order consumers:** They are the animals which directly depend on the herbivores for their food. They are also called as primary carnivores. E.g. cats, foxes, snake etc.

c. **Tertiary consumers or third order consumers:** They are the large animal which directly depends on the primary carnivores for their food. They are also called as large carnivores. E.g. wolves.

d. **Quaternary consumers or fourth order carnivores:** They are the largest animals which directly depend on the large carnivores for the food. They are also called as omnivores. E.g. lions, Tigers.

Decomposers: They are microorganisms like bacteria and fungi. They attack the dead bodies of producers and consumers and then decompose them into simple compounds. During the decomposition, simple inorganic and organic substances are released. These substances are utilized by the producer for the synthesis of their own food. The decomposers are also called as Saprotroghs.

Function of ecosystem: Ecosystem receives energy from the sun and passes it through biotic component. Various nutrients and water are exchanged with in the biotic component and also abiotic component. The major functions of an ecosystem are as follows:

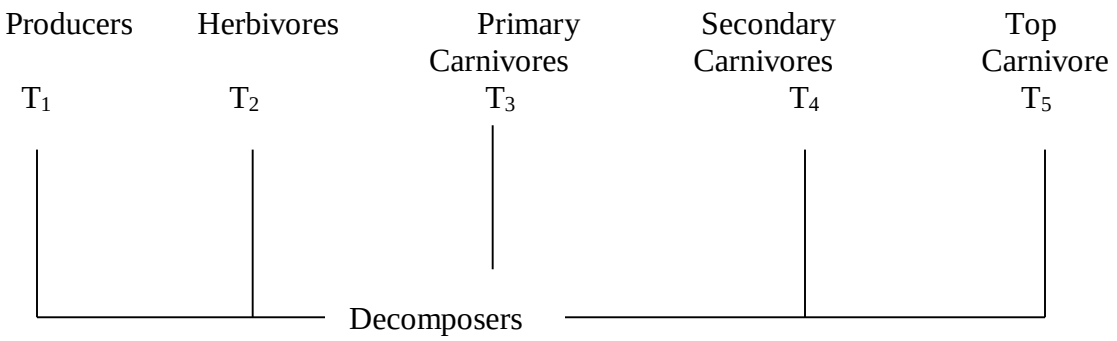
i. Productivity and decomposition
ii. Energy flow
iii. Cycling of nutrients
iv. Food chain, food web and trophic structure
v. Ecosystem development and regulation.

Productivity: The rate of organic matter or biomass production is called productivity. The productivity of an ecosystem is two types. They are primary productivity and Secondary productivity. "***The rate at which solar energy is captured by the producers for the synthesis of organic compound through photo synthesis is called primary productivity***". "**The rate of increase in the biomasses of consumers per unit area and time is called secondary productivity**".

Decomposition: The conversion of complex organic materials into inorganic raw materials like CO_2, H_2O and various nutrients by decomposer which is called decomposition process. The upper layer of the soil is the main site for decomposition in the ecosystem. Decomposition makes inorganic raw materials available for reutilization

by the plants. The flow of energy is mediated through a series of feeding relationships in a definite pattern is known as food chain. Nutrients also move along the food chain (*i.e.* one organism eats the other which in turn, eaten by other organisms). The producers and consumers are arranged in the ecosystem in a definite manner and their interaction along with population size is expressed as trophic structure. Each food level is known as trophic level and the amount of living metles at each trophic level at a given time is known as standing biomass.

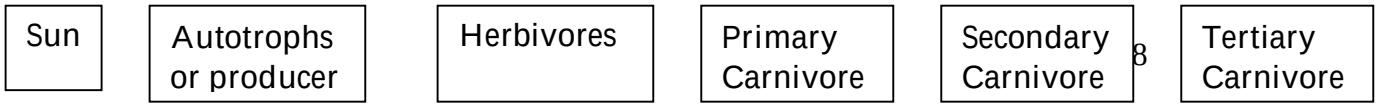
Trophic level organization: Food relationship between producers and the consumers is explained by Trophic (Food) structure of ecosystem which is based on the existence of several trophic levels in the ecosystem. The producers or autotrophs form the first trophic level "T_1", Herbivores are represented as "T_2" level, Carnivores are represented as "T_3" to "T_5" trophic level. "T_3" for primary carnivores "T_4" Secondary carnivores and T_5 for Top carnivores. They are represented as follows:



Trophic levels in ecosystem.

Before going to discuss about energy flow or nutrient cycling, we must be know about the food chains and food webs which provide an idea about the energy and materials flow takes place in ecosystem.

Food Chain: The transfer of food energy from the plants (Producer) through a series of organism with repeated consumption is referred as a food chain or the transfer of energy from one trophic level to the next trophic level is called food chain. At each transfer stage, nearly 80 – 90 % of Potential energy is lost as heat. The general schematic representation of food chain is as follows:



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Schematic diagram of Food Chain

Types of food chain: All types of ecosystem possess two types of food chain; Grazing food chain and detritus food chain.

Grazing food chain: Food chain begins from a green plant. The flow chart of food from one level to another is schematically represented as follows:

Terrestrial Grazing food chain:

Plants ⟶ Buffer fly ⟶ Frog ⟶ Snake ⟶ Hawk

Aquatic grazing food chain:

Phytoplankton ⟶ Zooplankton ⟶ Small fish ⟶ Crane ⟶ Hawk

The food chains in aquatic and terrestrial grazing ecosystem are shown below:

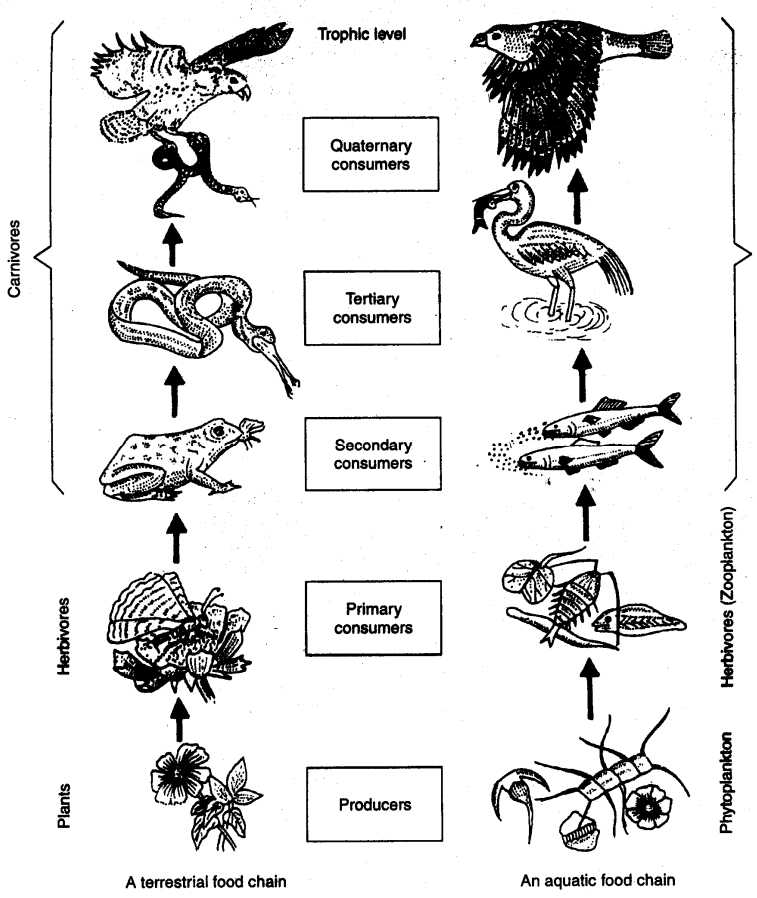


Figure 2.1. Terrestrial and aquatic grazing food chain

Components	Aquatic food chain	Terrestrial food chain
Producer	Phyto plankton	Crass
Primary consumer	Zoo plankton	Grass hopper
Secondary consumer	Small fish	Frog
Tertiary consumer	Crane	Snake
Quaternary Consumer	Hawk	Hawk

Detritus food chain: The food chain starts from organic matter of decaying animal and plant to microorganisms and then to detritus feeding organism, then follows to their predators. Example is mangrove ecosystem. The mangrove detritus food chain is shown in figure 2.2.

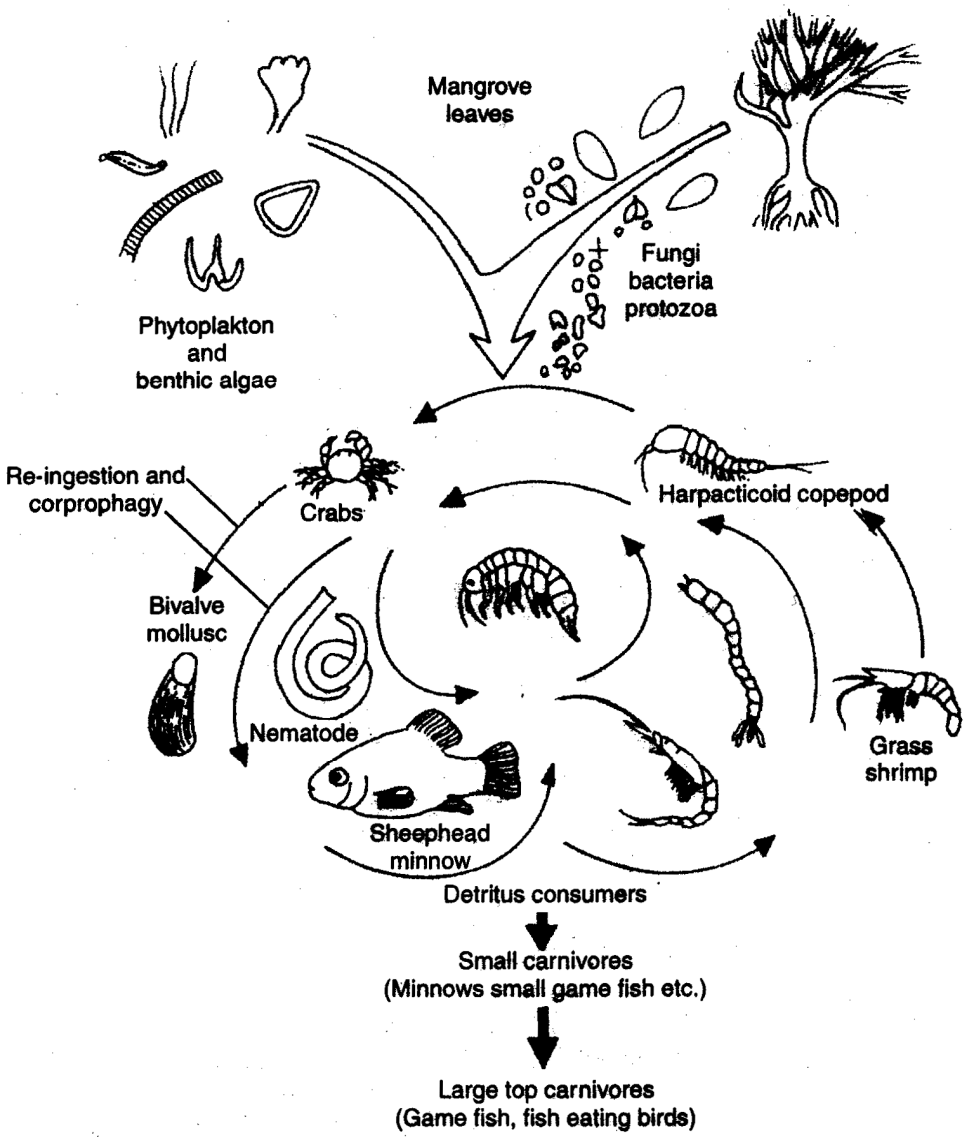


Figure 2.2. Mangroves detritus food chain

The food chart for detritus food chain is as follows:

Mangrove leaves ⟶ Microorganisms ⟶ Craps and shrimps ⟶
Small fish ⟶ large fish ⟶ fish hunting animals

a. Mangrove leaves fall into the warm and shallow water.
b. The leaves are eaten by fungi, bacteria, protozoa, etc., living on algae. Algae are eaten by small animals like crabs, insect's larvae etc.
c. Small animals are eaten by small fish and then by large fish followed by fish eating birds.

Food webs: Normally food chains do not function in isolated sequences but they are interlinked with each other forming some sort of pattern known as food-web. "**A network of food chains which are interconnected at various trophic levels so as to form a number of feeding connection amongst different organisms of a biotic community is called food web"**. The stability of an ecosystem depends on availability of food webs. The following figure 2.3 will explain the significance of food – web in an ecosystem.

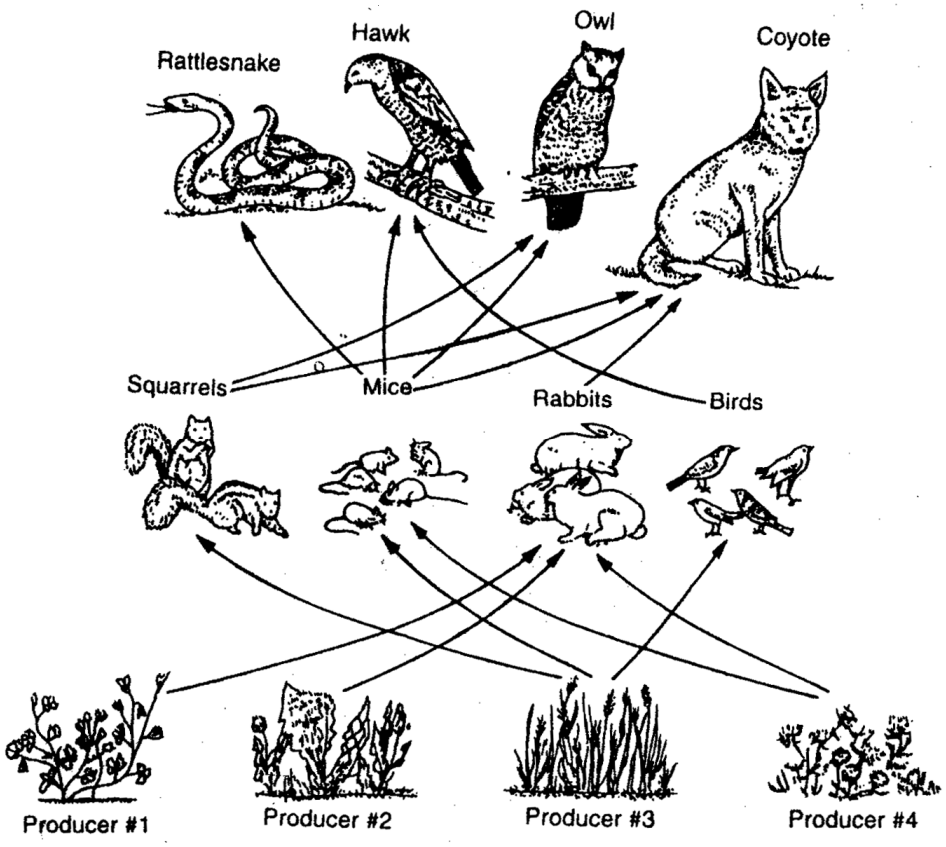


Figure 2.3. Food web

Differentiation between food chain and food web

Why nature has evolved food webs in ecosystems instead simple linear food chains? This is because food web gives greater stability to the ecosystem. In a linear food chain, if one species suffers then the species in the subsequent trophic levels are also affected. But in food web, there are a number of options available at each trophic level. So if one species is affected, it does not affect other trophic levels severely.

Significance of food chain and food web

1. The food chains and food webs play a significant role in the ecosystem because the two important functions such as energy flow and nutrient cycling take place through them.
2. The food chains also help in maintaining and regulating the population size of different animals and thus, help to maintain the ecological balance.
3. Food chain shows a unique property of biological magnification of some chemicals. There are several pesticides, heavy metal and other chemicals which are non-biodegradable in nature. Some chemical are not decomposed by microorganisms and they keep on passing from on trophic level to another. At each successive trophic level, they keep on increasing in concentration. This phenomenon is known as **biomagnifications or biological magnification**.

Ecological Pyramids: The graphical representation of trophic structure and trophic function is referred as ecological pyramid. In this, the producer level forms the base and successive levels make up the apex (tip).

Types of ecological pyramids

They are **Pyramids of Number, Pyramids of Biomass** and **Pyramids of Energy.** The pyramids of numbers and biomass may be upright or inverted depending upon the nature of food chain in the particular ecosystem but the pyramids of energy is always upright.

Pyramids of number: It shows the relationship between producers, herbivores and carnivores at successive trophic levels in terms of their number. In a grassland

ecosystem, the producers (Grasses) are maxima in number. This number decreases towards the apex, *i.e.* primary consumers (herbivores) like rabbits, mice etc. are less in number than the grasses. The secondary consumer such as snakes and lizards are lesser in number than rabbits and mice. Finally, the top consumers like hawks are least in number, thus the pyramid becomes up right.

Figure 2.5. Pyramid in Number of pond Ecosystem

In pond ecosystem the pyramid is upright

1. The producers are mainly the phytoplanktons as algae, bacteria etc. are maximum in number.
2. The herbivores which include small fish, rotifers, etc are lesser in number than producer.
3. Secondary consumers such as small fishes eating each other are lesser in number than the herbivores.
4. Finally the tertiary consumers *i.e.*, bigger fishes are least in number. So the pyramid is upright.

In a forest ecosystem, the pyramid of number is different in shape.

1. The producers are larger sized trees which are less in number and form the base of the pyramid.
2. Primary consumer includes fruits eating birds elephants, deer etc are more in number than producers.
3. There is a gradual decrease in the number of successive carnivores, thus making the pyramid again upright

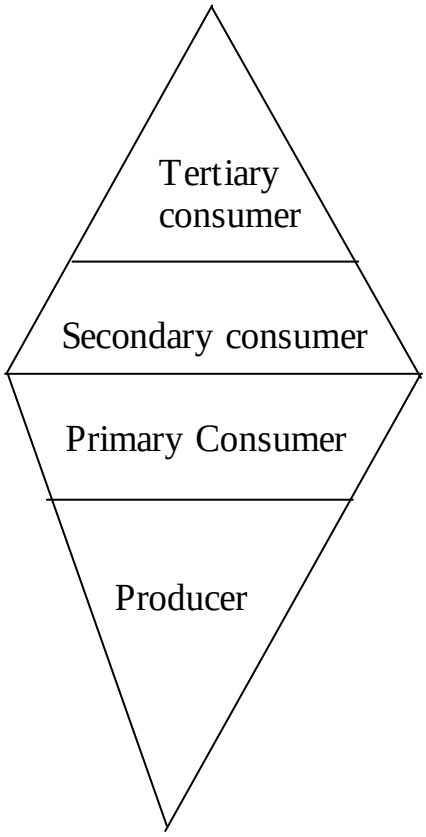


Figure 2.6. Pyramid in Number of forest Ecosystem

Pyramid of Biomass: It shows the quantitative relationships of the standing crops in various trophic structures in the ecosystem

1. In grassland and forest, there is a gradual decrease in biomass of organisms at successive levels from the producers to the top carnivores. Thus, these pyramids are up right.
2. However in pond ecosystem, the producers are small organisms and hence their biomass is least. This value gradually shows an increase towards the apex of the pyramid, thus making the pyramid inverted in shape.

Pyramids of energy: The energy pyramids reflect the best picture of overall nature of the ecosystem. In this pyramid, the numbers and weight of organisms at any trophic level depends on the rate at which food is produced but not on the amount of fixed energy at any level in a given time. It is always upright since there will be always a gradual decrease in the energy content at successive trophic levels from produces to various consumers. A typical ecological pyramid is shown is figure 2.4.

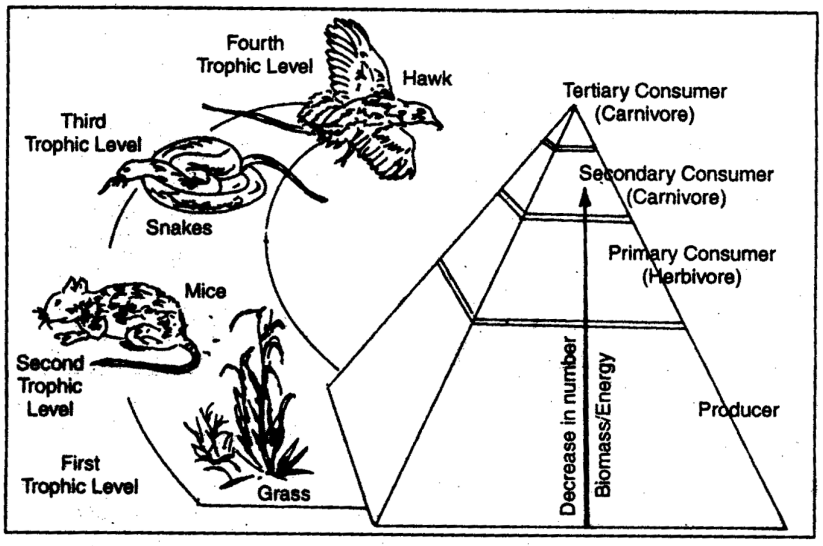


Figure 2.4. Ecological pyramid

Energy flow in the ecosystem: The functioning of ecosystem depends on the flow of energy through matter. Energy enters into the ecosystem from the solar radiation and is converted into chemical energy by the producers. From the producer, the energy passes from one trophic level to another is occurred by the process of eating. The flow of energy from one trophic level to another in the ecosystem follows the lws of thermodynamics.

1. **Firs law of thermodynamics**: Energy can neither be created nor destroyed, although one form of energy is converted into another form. If an increase or decrease occurs in internal energy (ΔE) of the system, work is done and heat is liberated or absorbed. It is mathematically written as

$$\Delta E = q - \acute{\omega}$$

During energy transformation, the kinetic energy is responsible for doing the work. All physical and chemical process proceeds with a decrease in free energy until they reach equilibrium, where free energy of the system is at a minimum. It is represented as follows:

$$\Delta G = \Delta H - T \Delta S$$

$\Delta G \rightarrow$ Change in free energy of the system

$\Delta H \rightarrow$ Change in enthalpy of the system

$\Delta S \rightarrow$ Change in entropy of the system

$T \rightarrow$ absolute temperature.

According to thermodynamics, 100 % transformation of energy from one trophic level to another is impossible.

i) There is unidirectional flow of energy in the ecosystem *i.e.*, from the producer through herbivores to carnivores. The energy cannot be transferred in the reverse direction.

ii) The amount of energy flow decrease with successive trophic levels. Producer capture only small fraction of solar energy. Part of energy captured by producer is used for gross production. This gross primary production (GPP) is used for maintenance (respiration) and providing food for herbivores. The unused net primary production (NPP) is serves as energy sources for decomposers. Thus, small amount of energy is captured by plants and part of energy is transferred to consumers.

According to ecology, the above relationship is represented as

$$P_g = P_n + R$$

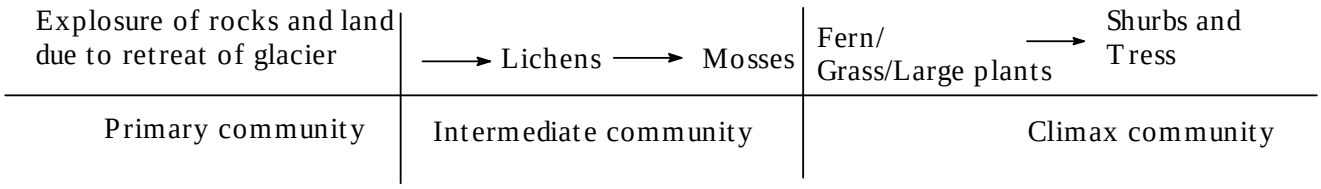
$P_g \rightarrow$ gross productivity (or) energy input

$P_n \rightarrow$ net productivity (or) energy stored.

$R \rightarrow$ respiration (or) energy used to do work.

The energy assimilated by the herbivores is used for respiration and a fraction of energy is transferred to decomposers. The herbivore level of energy is utilized by the carnivores or gets transferred to decomposers after the death of herbivores. In this way, only a small fraction is used to support carnivores productivity. In the same way, the energy available at carnivore trophic level is divided and a very small fraction is used to support the next trophic level.

Ecological Succession: A biotic community destroyed by natural or human activities is gradually replaced in a series of changes until climax community is reached. The replacement of one biotic community by another is called "Succession" or the gradual changes in species composition of a given area are called ecological Succession. "**The change of plants and animals communities in an orderly sequence in area, resulting in establishment of stable or climax community is called ecological succession."** The following diagram explains how trees came into existence in the environment.



Types of Ecological Succession: There are two different types of Succession which are Primary Succession and secondary Succession.

Primary Succession: It involves the gradual establishment of biotic community on nearly lifeless ground. It begins with an essentially lifeless area where there is no soil in a terrestrial ecosystem or no bottom sediment in an aquatic ecosystem.

Secondary Succession: It involves the establishment of biotic communities in an area where some type of biotic community already present. It begins in an area where the natural community of organisms has been disturbed, removed or destroyed but some soil or bottom sediments remains. On the other hand, the secondary succession is the sequential development of biotic community after the complete or partial destruction of an existing community. A mature or intermediate community may be destroyed by natural events like volcanic eruption, floods, drought, fires or mining.

Process or Mechanism of Succession: The process of ecological succession occurs through a number of sequential steps which are follows:

1. **Nudation:** It is the development of a base area due to several reasons such as land slides, erosion, deposition of soil particles, clearing of forests, overgrazing or other catastrophic agency.
2. **Migration or dispersal**: The seeds, or spores of the organisms reach the base area, is called migration. It is brought about by air, water, animals or man. The first arrivals in a base area are called pioneers or pioneer colonizers.
3. **Ecesis (Establishment**): After reaching the new area, the organisms padjust itself in the conditions of environment is known as ecesis. After migration of plants, seeds germinate, grow and start to reproduce. Only few of them are capable of doing this under harsh condition. Thus, as a result of ecesis, the individual species become established in the area.

4. **Aggregation:** After ecesis, the increase in the number of individuals is called aggregation.
5. **Invasion:** Migration does not end with the establishment of pioneers. From time to time pioneers of new species continue to reach the area under colonisation. If they are able to establish in new area then the process is called Invasion and the new organism is called Invaders. Invaders are able to establish them self's only if they are more aggressive than colonisers
6. **Competition and co-action**: After aggregation of a large number of species of limited place then there is competition arises in between the colonisers and invaders for space and nutrition. Both the species affect each others life in various ways. This is called co-action .The species if unable to compete with others species would be discarded. .To withstands competition reproductive capacity wide ecological amplitude are of much help to species.
7. **Reaction**: It is the changes brought about by colonisers in the habitat. The changes takes place in the soil, water, light condition, temperature etc. Due to all this the environment is modified and becoming unstable for the exciting community, which is replaced by another community .The whole sequence of communities one another in the given area is called sere and the various communities constituting the sere as seral communities, seral stages or developmental stages
8. **Stabilisation**: Continuous competition invasion and reaction give rise to continuous changes in the environment in the structure of vegetation. After a long interval some individuals arise which are incomplete harmony with the climate of the area. They become dominant and create condition favourable for the growth of the plants below them. The latter cannot live without the presence of the dominants .The dominants produce particular physiognomy which is characteristics of the vegetation. No further changes occur in the vegetation. This vegetation is called climax stage or climax community.

Biodiversity:

Bio means life and Diversity means variety. Biodiversity is defined as "richness of species (micro organisms, plants and animals) occurring in a given habitat". Or variety of species (micro organisms, plants and animals) present in a given habitat"

Biodiversity includes

i) Different types of animals, birds, fish, insects, plants, bacteria and other species
ii) Different ways in which species interact with their environment
iii) Different ways species live together
iv) Different characteristic within a species

Types or Levels of Biodiversity: There are three different types of biodiversity

1. Genetic diversity
2. Species diversity
3. Ecosystem diversity

These three types of biodiversity must work together to create the complexity of the life on earth.

Genetic diversity: The genetic variation existing within a species is called genetic diversity.

- Genes are the basic units of all life on earth.
- They are responsible for both the similarities and the differences between organisms.
- Each species is made up of their own particular genetic composition. This means a species may have different populations, each having different genetic compositions.
- To conserve genetic diversity, different populations of a species must be conserved, this type of diversity occurs at finer levels of organisms.

Species diversity: Species diversity is the variation exists between different species. Species diversity is the number of different species of living things available in an area. Species is a group of plants or animals that are similar and able to breed and produce viable offspring under natural conditions.

Plant species: Apple, mango, grapes, wheat, rice etc.,

Animal species: Lion, tiger, elephant, deer, etc.,

Ecosystem diversity: Ecosystem diversity is the variation exists at the habitat level is known as ecosystem biodiversity. An ecosystem is a community of organisms and their physical environment interacted together. An ecosystem can cover a large area, such as a whole forest or a small area, such as a pond. This type of diversity is considered as a complex level of diversity.

Functions or Significance of Biodiversity: There are two main function of biodiversity

1. It is the sources of species on which the human compete depend for food, fibre, shelter, fuel and medicine.
2. It depends on the biosphere, which in turn leads to the stability in climate water, soil, air and the overall health of biosphere.

Values of Biodiversity

The real assert of the country is directly related to its biodiversity. A rich biodiversity is wealth of the nation. The value of particular species will be known only when it is not available. Valuation of biodiversity in any ecosystem is quite difficult. However few parameters are used to assess the value of biodiversity. They are direct economical value and indirect economical value.

Direct value of Biodiversity: In direct use values, the biodiversity products are harvested and consumed directly.

Examples: Food, drugs, fuel etc.

There are two types of direct values.

1. Consumptive use value
2. Productive Use value

Consumptive use value: The consumptive use value is the value of natural products that are consumed directly without passing through a market.

Examples: Fuel, Food, drugs, fibre etc.

Food: A large number of wild plants are consumed by human beings as food. About 80000 edible plants species have been reported from wild. About 90% of the present food crops have been domesticated from wild trophic plants. A large number of wild animals are also sources of food.

Drugs and medicines: About 70% of the world's population depends upon plants or plants extracts for medicines.

Penicillin is derived from Penicillium, Tetracycline is derived from bacterium, and Quinine is derived from Cinchona tree which is used to cure the malaria. Similarly, vinblastin and vincristine are anticancer drugs which are derived from Periwinkle plant.

Fuel: The fossil fuels coal, petroleum and natural gas are products of fossilized biodiversity. Firewood collected by individuals are not normally marketed, but are directly consumed by tribals and local villagers.

The high consumptive use values on resources have following problems.

1. Over-exploitation of wildlife in developing countries.
2. loss of traditional controls on hunting
3. Loss of wildlife populations at productive levels

But the consumptive use value benefits to the communities closest to resources if harvested sustainably with proper management.

Productive use value: The productive use value is the commercial value of natural products that are sold through a market. The natural products are derived from plants and animals.

It includes the animal products like tusks of elephants, musk from musk deer, silk from silk warm, wool from sheep, fir of many animals, etc all are sold in the market. Many industries are dependent upon the productive use values of biodiversity. Example: The paper and pulp industry, play wood industry, Railway sleeper industry, silk industry, textile industry, ivory works, leather industry, pearl industry etc.

Indirect values of Biodiversity:

These values involve the functions performed by biodiversity which are not of any direct use. Plants and animals are supported to human beings by the services provided by their environments.

Examples: Ecological functions, flood and storm protection, waste assimilation, microclimatic functions, nutrient cycles, photosynthesis, carbon stores, soil production etc.

The indirect value of biodiversity divided into following type:

1. Social values
2. Ethical value
3. Aesthetic value
4. Option value
5. Ecosystem value

1. **Social values:** These are the values associated with the social life, customs, religion and psycho-spiritual aspects of the people.

   Examples

   Holy plants: Some plants are considered holy and sacred in our country like Tulsi, Peepal, Mango, Lotus, etc. The leaves, fruits or flowers of these plants are used in worship.

   The tribal people are closely linked with wild life in the forest. Their social life, songs, dances and customs are closely woven around the wildlife.

   Holy animals: Many animals like cow, snake, bull, Peacock, Owl etc have significant place in our psycho – spiritual arena and thus hold special social importance. Thus biodiversity has distinct social value attached with different societies.

2. **Ethical value:** Ethical values related to biodiversity conservation which is based on the importance of protecting all forms of life. Man is only a small part of the earth's family of species. Both plants and animals have an equal right to live and exist on our planet. Indian civilisation has over several generations preserved nature through local traditions. A large number of sacred groves are preserved by tribal people.

3. **Aesthetic value:** The beautiful nature of plants and animals insist us to protect the biodiversity.

   Biodiversity is a beautiful and wonderful aspect of nature. Sit in a forest and listen to birds, watch a spiders weave its complex web. Observe a fish feeding. It is a magnificent and fascinating. Symbols from wild species such as lion of Hinduism, the elephants of Buddhism etc.

4. **Option value:** The option values are the potentials of biodiversity that are presently unkown and need to be known. The optional value of biodiversity suggests that any species may be proved to be valuable species after someday.

   Examples: The growing biotechnology field is searching a species for causing the diseases of cancer and AIDS.

Thus the preservation of biodiversity must be including traditionally used strains, already existing crops and domestic animals.

5. **Ecosystem value or Non consumptive value:** These are the indirect values which deal with nature's functions and services. These include photosynthesis of plants, thereby providing support to the system of other species, maintaining water cycles, regulating climate, production and protection of soil, absorption and breakdown of pollutants, recreational, socio-cultural, scientific, educational, spiritual and historical values of natural environment.

Endangered and endemic species of India:

Endangered species is a plant, animals or micro-organisms that are immediate danger of biological extinction is called endangered species or threatened species.

Number of endangered species in India

Group of endangered species	Number of endangered species
Plants	250
Birds	70
Mammals	86
Reptiles	25
Amphibians	3
Fishes	3
Molluscs	2
Insects	50

A species of endangered reptiles, mammals, birds and plants are given below:

Plants	Medicinal plants (like rauvol fia serpentine) and sandal wood tree (like santalum, cycas bed donei)
Birds	Peacock, Siberian white crane, pelican, Indain bustard
Reptiles	Tortoise, green sea turtle, gharial, etc
Mammals	Indian wolf, red fox, tiger, Indian lion, golden cat, desert cat, etc.,

Endemic species: The species which are found only in a particular region are known as endemic species. In India, nearly 62% of our endemic species are found available in Himalayas and Western Ghats.

Examples

Endemic flora species: Nepenthes khasiana, Pedicularis Parroter, Sapria himalayana,

etc.,

Endemic animals: Western Ghats are particularly rich in amphibians (frogs, toads, etc.,)and reptiles (lizards, crocodiles, etc.,).

Endemic fauna species: Monitor lizards (varanus), Indian salamander and viviparous

(Nectophhryne).

Vulnerable species: A species is said to be vulnerable when its population is facing continuous decline due to habitat destruction or over exploitation. Such species is till abundant.

Rare species: A species is said be rare, when it is localised within restricted area (or) they are thinly scattered over a more extensive area.

Hot spots of Biodiversity

The richness of species concentration at a particular region is called biodiversity hot spots.

The hot spots are characterized by high concentration of endemic species and are experiencing unusually rapid rates of habitat loss or modification. India has two identified hot spot: They are Eastern Himalayas and Western ghats.

In whole of eastern Himalayas have 9000 types of plants with 3500 endemic species. Some of the essential species of this region are:

1. 55 endemic flowering plants are recognized as rare.
2. Area is recognized as “cradle of speciation” Species of families of monocotyledons, orchidaceous, zingiberacae and arecaceae are abundant in it.
3. Rich in wild relatives of plants of economic significance – rice, banana, citrus, ginger, chilli, jute and sugarcane.
4. Centre of origin and diversification of five palms of commercial importance – coconut, arecanut, Palmyra palm, sugar palm and wild data palm.

5. Tea is reported to be in cultivation in this region for the last 4000 years.
6. Area is rich in avian diversity – 60% of Indian birds are in this region, endemic genera of lizards, 35 endemic reptile species, including two turtles.

Western ghats region have 315 types of vertebrates belonging to 22 genera are endemic which include 12 species of mammals 13 species of birds, 89 species of reptiles, 87 species of amphibians 104 species of fish, 235 species of endemic flowering plants and 1500 endemic species of plants.

Threats to biodiversity

Any disturbance is an ecosystem tends to reduce its biodiversity. The disturbance is generated due to increase in human population and industrialization. When the waste is disposed into the environment which leads to more changes in biodiversity.

Causes for loss of Biodiversity (or) Various Threats to biodiversity

Habitat destruction, over exploitation, pollution and species introduction are the major reason of biodiversity loss in India. Some natural calamities like droughts, diseases, cyclones and floods also lead to biodiversity loss.

1. Habitat loss: Habitat is the sum of the total of the environmental factors, food, water and shelter, which is needed for a given species to live comfortable and reproduce in a given area. The habitat of an animal can be destroyed by environmental factors and in which man play a significant role.

The deforestation, drainage or filling of wet lands, overgrazing, expending agriculture, urban development, construction of highway, building of dam, strip mining are some of the examples of habitat alteration. Natural activities like flood, cyclone, earthquake, landslides, drought, tsunami etc are responsible for loss of habitat. Some of the examples for habitat loss leading to special threat are

- Flooding leads to loss of nutrients
- Deforestation leads to loss of wood and animals.
- Overgrazing leads to death of herbivores
- Poor agricultural practice leads to pests and herbs attack

2. Poaching of Wildlife: Poaching means killing of animals or commercial hunting. They are two types poaching

a) Subsistence poaching: Killing animals to get enough food for our survival is subsistence poaching.

b) Commercial poaching: Hunting and killing animals to sell their products is called commercial poaching.

Illegal trade of wild life products by killing prohibited endangered animals is called poaching. The decline in the number of species is due to the following reasons.

1. The species, particularly cattles are sold and hacked to death for consumption (eating).
2. The wild life, say the elephants are killed to obtain their teeth which is then sold for substantial amount of money.
3. The tigers/lions are killed to extract their skin to be sold for money. Similarly furs, skins, ivory, horns etc. are obtained from different forms of wild life. These are used to prepare various end use products such as medicines, leather jackets, shoes, purse and decoration pieces.

Threats of poaching are more on some species and less to others. It depends upon their need in the market and their social values. For example, the need for tortoise and snakes has their market value for human consumption is higher. Similarly, the tiger skin is the status symbol for many people therefore it is used to decorate the drawing rooms.

Tribal people hunt for their own survival of day to day food. Poaching is also encouraged by political parties for the business and economy. Many tribal people use the medicine derived from wildlife and plants.

3. Man and wildlife conflicts:

Man-wild animal conflicts arise, when wildlife starts causing immense damage to the man. Under such condition it is very difficult for the forest department to compromise the affected villagers and to gain the villagers support for wildlife conservation.

Examples:

1. In Sambalpur, Orissa, 195 humans were killed in the last 5 years by elephants. In retaliation, the villagers have killed 98 elephants and badly injured 30 elephants.

2. In the border of Kote-Chamarajanagar, Mysore, several elephants was killed because of the massive damage done by the elephants to farmar's cotton and sugarcane crops.
3. Very recently, 14 persons were killed by leopards in Sanjay Gandhi Nationa Park, Powai, Mumbai.

Factors influencing man-animal conflicts:

1) Shrinking of forest cover compels wildlife to move outside the forest and attack the field and humans.

2) Injured animals have a tendency to attack man. Usually the female wildlife attacks the human if she feels that her new cubs are in danger.

3) Often the villagers put electric wiring around their crop fields. The elephants get injured, suffer in pain and start violence.

CONSERVATION OF BIODIVERSITY

Conservation is the management of natural resources, ecosystems and biodiversity etc. of the biosphere; so that maximum benefits are derived by the present generation and substantial potential is preserved for the future generation.

The major objectives of the biodiversity conservation are as follows:

1. To maintain ecological balance
2. To allow continuance of natural process.
3. To safeguard the life supporting system.
4. To preserve the biodiversity and minimise/avoid the extinction of species
5. To utilize the natural resources

To fulfil the above objectives, various means are adopted for conservation of plants and animals. These are described in subsequent articles.

Biodiversity Treaty: To protect species and ecosystem, various strategies are formulated and executed. Some of its features are given below:

1. Every state has a sovereign right on its biological resources
2. Transfer of biotechnology, genetic and other related technologies from developed countries to developing countries should be done at favourable terms.
3. The benefits arising out of the use of skills, practices, knowledge and innovations should be shared by all nations.

Benefits or advantages of Biodiversity conservations:

- It leads to conservation of essential ecological diversity and life supporting systems.
- Preserves the genetic diversity of plants and animals
- Ensures the sustainable utilisation of life supporting system
- It provides a vast knowledge of potential use to the scientific community.
- Maintains unchanged biotic communities in their natural form.
- Provides immediate benefits to the society such as recreation and tourism.
- Provides the control against the changes brought about by other forms of land use.

Types of conservation of Biodiversity:

Based on habitat, there are two main approaches are adopted to conserve the wildlife in protected habitats.

1. In-situ or On-situ conservation
2. Ex-situ conservation

In the former approach, the protection is given to all wild flora and fauna. But in the latter approach, protection is given to endangered and rare species.

In-situ conservation: In-situ conservation involves protection of fauna and flora within its natural habitat, where the species normally occurs is called in-situ conservation.

The natural habitats maintained under in-situ conservation are called protected areas. Protected areas such Biosphere reserves, National parks and wild-life sanctuaries are managed.

At present, 7 Biosphere reserves, 80 National parks and 420 wild-life sanctuaries are available in our nation.

Biosphere reserves conserve some representative ecosystems as a whole for long – term in-situ conservation. Within Biosphere reserve, we have one or more National parks. Example: Nilgiri Biosphere Reserve has two National Parks, i.e. Bandipur and Nagarhole National park.

Role of biosphere reserves

- ✓ It gives long-term survival of evolving ecosystem.
- ✓ It protects the endangered species.

- ✓ It serves as site of recreation and tourism.
- ✓ It is also useful for educational and research purposes.

Restriction: No tourism and explosive activities are permitted in the biosphere reserves.

National Park is an area depicted for the conservation of wildlife along with its environment. Grazing of domestic animals, all private rights and forestry activities are prohibited within national park. Each National park aims at conservation of some particular species of wildlife along with others. Examples: Periyar national park at kerala where elephants and tiger are conserved.

Role of National Park

- ✓ It is used for enjoyment through tourism, without affecting the environment.
- ✓ It is used to protect, propagate and develop the wildlife.

Restriction:

- ✓ Grazing of domestic animals inside the national park is prohibited.
- ✓ All private rights and forestry activities are prohibited with in a national park.

Wild sanctuaries are an area, which is reserved for the conservation of animals only.

Role of wildlife sanctuaries

1. It protects the animals only.
2. It allows the operations such as harvesting of timber, collection of forest products, private ownership rights and forestry operations provided it does not affect the animals adversely.

Restriction: Killing, hunting, shooting or capturing of wildlife is prohibited except under the control of highest authority. However, private ownership rights are permissible and forestry operations are also permitted to an extent that they do not affect the wildlife adversely. Example: Mudamalai wildlife Sanctuary and Vedanthangal Bird sanctuary at Tamilnadu.

Advantages:

1. Very cheap and convenient.
2. In natural system, species are not only survived and also multiply.
3. The species gets adjusted to natural disaster like forest fires, floods, cyclones etc.
4. It is better method foe long-term conservation

Limitations:

1. A large area of the earth surface is required to preserve the full complement of biodiversity.
2. Maintenance of the habitat is no proper due to shortage of staff.
3. Proper protection against environmental pollution may not be enough in natural types of ecosystem.

Ex-situ Conservation: Ex-situ conservation involves protection of fauna and flora outside the natural habitats.

In this approach, the protection is given to the endangered and rare species in a man-made habitat other than their natural ecosystems. To accomplish this, the species are protected in artificial conditions under the supervision of biodiversity experts. To execute the process of protection, the endangered plant species are collected together and breed under desired conditions in seed banks, arboreta or botanical gardens. Similarly, the endangered animal species are collected in zoos, aquaria etc. and breed. The ex-situ conservation can be more effectively utilised by exposing the species to varying natural environment thereby retaining them to elope.

Advantages:

1. Due to controlled supervision, assured food, better shelter and security. So the species can survive longer and may breed more offspring than usual.
2. The quality of offspring may be improved by genetic techniques, If so required.
3. Breeding of hybrid species is possible.
4. Survival of endangered species is increased due to special care and attention.

Limitations:

1. It can be adopted only for few kinds of species
2. Over protection leads to loss of naturality.
3. Possible extinction of species due to

- Breeding in a changed environment
- Deteriorated quality of living

Unit III
ENVIRONMENTAL POLLUTION

Definition: The Excessive addition or discharge of unwanted matter into the environment causing damage to human, plant or animal life. The term environment includes air, water and land.

Pollution is generally classified into two types: They are Natural Pollution and Artificial pollution or man-made pollution.

Natural Pollution: This pollution originates from natural processes such as volcanic eruptions, forest fires, sea salt sprays, natural organic and inorganic decays, earthquake, etc.,

Artificial Pollution: This pollution originates due to man made activities which can be further classified into two types.

1. Classification according to environment: Air, water and land pollution
2. Classification according to pollutions: Radioactive pollution, thermal pollution, noise, pesticide, marine, chemical, industrial, biological, oil, smoke pollution etc.,

Pollutants: It is a harmful solid, liquid or gaseous substances present in the environment which causes dangerous effect for all living beings.

Classification of pollutants: Pollutants are classified into four different types such as Primary Pollutants, Secondary Pollutants, Biodegradable Pollutants and Non-biodegradable Pollutants

Primary Pollutants: The substance emitted directly from an identifiable source is called primary pollutants. Example SO_2, NO_2, CO_2 etc.,

Secondary Pollutants: These are the substances derived from primary pollutants by chemical reaction. Example: Primary pollutants such as hydrocarbons and NO_2 react in the presence of sunlight to form a group of nitrous compounds like peroxyacetyl nitrate (PAN) as secondary pollutants.

According to their existence in nature, the pollutants are classified into two types:

Biodegradable Pollutants: The pollutants that can be readily decomposed by microbial action or natural processes are called biodegradable pollutants. Example: Municipal sewage.

Non-Biodegradable pollutants: The pollutants which cannot be decomposed by microorganism present in the environment are called non-biodegradable pollutants, Examples: DDT, Mercury, lead etc.

AIR POLLUTION

Definition: Air pollution is the undesirable contamination of gas, smoke, dust, mist, odour or chemical particulates of the atmosphere which are dangerous to human beings, plants and animals.

Composition of atmospheric air:

Constituents	**%**
N_2	78
O_2	21
Argon (Ar)	< 1
CO_2	0.037
H_2O vapour	Remaining
O_3, H_2, NH_3	Trace amount

Sources of air pollution: There are two main sources of air pollution.

1. Natural sources
2. Man – made or anthropogenic sources

Natural Sources:

Natural sources cause large scale air pollution which is beyond the control of man.

1. Natural contaminants present in the air are pollen, fungal spores, cysts, bacteria and marsh – gas. Methane (CH_4) or marsh – gas is a hydrocarbon which is formed by decay of vegetable matter in marshy places (i.e. anaerobic decomposition of organic matter).
2. Carbon dioxide from the breakdown of methane
3. Volcanic eruptions release many gases and volcanic ash which cause air pollution.
4. Forest fire releases smoke and harmful trace gases.
5. Electric storms and solar flares pollute the air by the production of the harmful chemicals.
6. Salt spray oceans.

7. Dust storms

Man –made or anthropogenic sources: Industries are the sources of a wide variety of air pollutants like SO_2 gas, NH_3, NO_2, HF, HCl and H_2S gas besides dust, fumes, tar etc. Automobiles too result in emission of hazardous pollutants as by – product of the combustion of fossil fuel. Advanced agricultural techniques like spraying of crops for pest and weed control releases many pollutants like chlorinated hydrocarbon (BHC), organic phosphate, arsenic and lead etc. Nuclear explosions and explosives used in war result in radioactive fallout comprising radioactive pollutants like strontium – 90, cesium – 137, iodine – 131 etc. which have very long range effects.

Classification of Air pollutants: Air pollutants are classified into three categories based on origin, chemical composition and state of matter. According to origin, the pollutants are classified into two types.

Primary Pollutants: They are emitted directly from various sources to the atmosphere in a potentially harmful form. Example: CO, ash, smoke, dust, mist, inorganic gases such as SO_2, H_2S, Sulphide, nitric acid, ammonia, CO_2, HF, aromatic hydrocarbons and radioactive substances.

Secondary Pollutants: Some of the pollutants may react with one another or with the basic components of air to form new pollutants. They are called as Secondary Pollutants.

$$NO/NO_2 \xrightarrow{Moisture} (HNO_3/ NO_3^-) \text{ etc.}$$

H_2CO_3, H_2SO_4, smog, formaldehyde, phenoxy - acyl nitrate etc.

According to chemical composition:

Organic Pollutants: Hydrocarbon, aldehyde, ketones, alcohol and amines

Inorganic Pollutants: Carbon compounds, nitrogen compounds, and sulphur and halogen compounds.

Nitrogen compounds: NO_x (NO, N_2O, NO_2) and NH_3

Sulphur compounds: It include SO, SO_2, SO_3 and H_2S

Halogen Compounds: It includes HF and HCl.

According to state of matter:

Gaseous pollutants: CO, CO_2, NO_X and SO_X

Particulate pollutants: It consists of finely powdered solids or liquids or existing colloidal substances which include smoke mist, dust etc.

Environmental effect of air pollution:

Effect of air pollution on human health: Air pollutants have many acute as well as chronic effects on human health. These are as follows:

1. **CO**: It react with haemoglobin in red blood cells and reduces the ability of blood to bring O_2 to body cells and tissues which causes Head aches and Anemia. At high levels it causes coma, Irreversible brain cell damage.
2. **NO_2**: Irritated the lungs, causing bronchitis and pneumonia. Reduction in functioning of lungs and respiratory illness.
3. **SO_2**: It causes breathing problems for healthy people. Reduces visibility.
4. **Hydorcarbon**: Low molecular weight hydrocarbon cause eye irritation, coughing, drowsiness. High mol. Weight hydrocarbon cause carcinogenic problem(cancer).
5. **Lead particulates** (From automobile exhausts): cause lead poisoning resulting in convulsions, weakens the CNS, coma and even death.
6. **Cadmium particulates** (through cigarette smoking): cause cardiovascular diseases, kidney and liver damage and even death.
7. **Nickel particulates** (in tobacco smoke) results in respiratory damage.
8. **Mercury** (Combustion of fossil fuels, plants) results in nerve, brain and kidney damage.
9. Radioactive fallout has somatic and genetic effects on future generations.

Effect of air pollution on plants: Spraying of pesticides and other agricultural practices has exposed the plants to a large number of air pollutants affecting their growth and metabolism by destroying chlorophyll and disrupting photosynthesis.

1. SO_2 bleaches the leaf surface and cause chlorosis (i.e. loss of chlorophyll and yellowing of the leaf) especially in leaf vegetables.
2. NO_2 causes premature leaf fall (abscission) and suppressed growth of plants resulting in reduced yields of crop plants.
3. Ozone causes necrosis (dead areas on a leaf structure) and damages leaves.
4. PAN (peroxyacyl nitrate) damages leafy vegetables causing premature fall, decolouration and curling of sepals.

Effect of air pollution on materials: Materials are affected by air pollutants in the following four ways

1. Corrosion
2. Abrasion
3. Deposition and removal of materials
4. Chemical attack

The damages caused to various materials by air pollutants are:

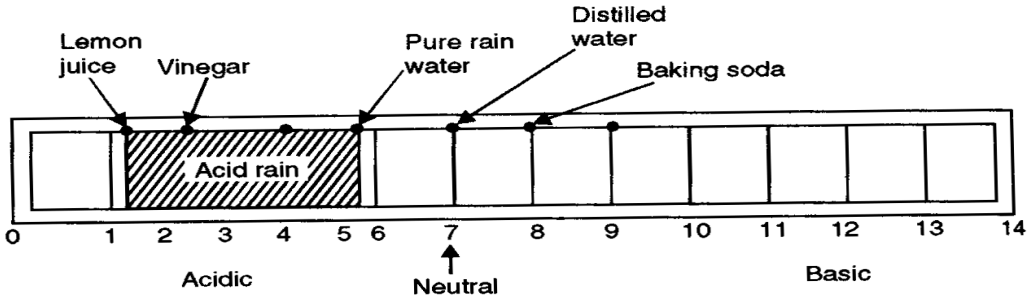
5. Paints are decoloured by SO_2, H_2S and particulates
6. Metals undergo corrosion and tarnishing by SO_2 and acid gases.
7. Paper becomes brittle and leather undergoes disintegration by SO_2 and acid gases.
8. Ozone, SO_2, NO_2 and acid gases discolour, deteriorate and reduce the tensile strength of textiles.
9. **Acid rain:** Normal rain water is always slightly acidic because of the presence of CO_2 in the atmosphere gets dissolved in it. Because of the presence of SO_2 and NO_2 gases as pollutants in the atmosphere, the pH of the rain water is further lowered. This type of precipitation of water pH is called acid rain. This acid rain damages the building materials.

$$SO_2 + H_2O \rightarrow H_2SO_3$$

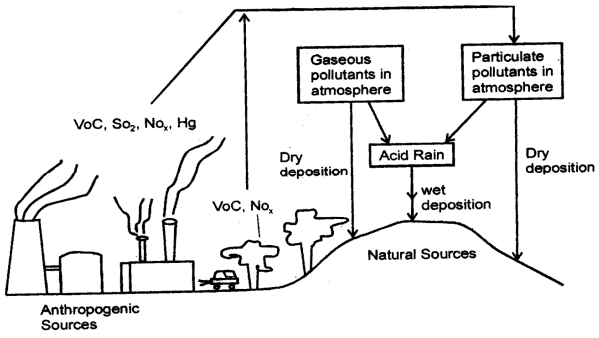
$$2H_2SO_3 + O_2 \rightarrow 2H_2SO_4$$

$$2SO_2 + O_2 \rightarrow 2SO_3$$

$$SO_3 + H_2O \rightarrow H_2SO_4$$

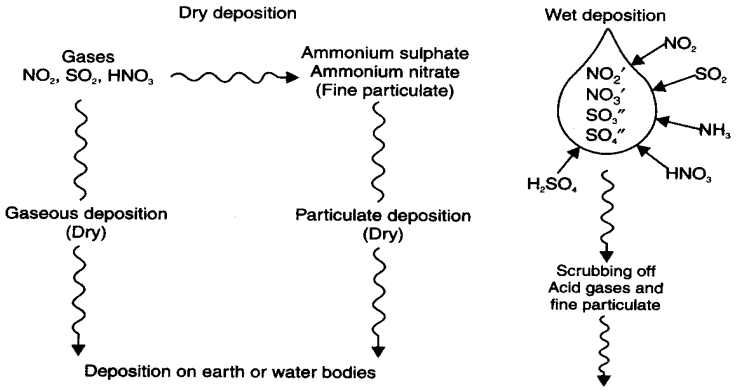


During the 1980, acid rain emission becomes the major environmental issue. The more precise term is acid deposition, which has two parts viz wet and dry deposition. Snow sleet and mist are collectively known as “wet deposition” and gases, dusts and among collectively known as “dry deposition”. The acid deposition is explained by using following diagram.



Acid deposition from various sources

Thermal power plants, industries and vehicles release nitrous oxide and sulphur dioxide into atmosphere due to burning of coal and oil. These gases are oxidized over several days by which time they travel several thousand kilometres. When these oxidized gases react with water vapour in the atmosphere, they form acids and descend on to earth as “acid rain” through rain water. The acid deposition is explained by using following diagram.



Sulphuric acid forms a major fraction of acid rain, followed by nitric acid and a very small fraction of other acids. However, in urban areas calcium, magnesium and

ammonium ions helps to neutralize the rain drop shifting the overall H^+ towards basic scale. The over all P^H of any rain drop is due to the net effect of carbonic acids, sulphurinc acid, nitric acid and other acidic constituents or any neutralizer (ammonia).

In the absence of rain, dry deposition of acid may occur. Acid forming gases like oxides of sulphur and nitrogen and acid aerosols get deposited on the surface of water bodies, vegetation, soil and other materials one moist surfaces or in liquids these acid forming gases can dissolve and form acids similar to that formed in acid rain. In India, acid rain is recorded from certain places as follows:

Name of place	**pH of rainwater**
Kodaikanal	5.18
Minicoy	5.52
Mohanbari	5.5

Effect of acid rain: Acid rain causes a number of harmful effects below 5.1. The effects are visible in the aquatic system even at pH less than 5.5

1. It causes decay of buildings which are made up of marble. Example: Tajmahal. Crystals of calcium and magnesium sulphate are formed as a result of corrosion caused by acid rain.
2. It damages stone statues. Price less stone statues in Italy have been partially dissolved by acid rain.
3. It damages metals and car finishes
4. Aquatic life especially fish are badly affected by lake acidification
5. Aquatic animals suffer from toxicity of metals such as Al, Hg, Mn, Zn and Pb which leak from the surrounding rocks due to acid rain. It results in reproductive failure and kil ling of fish.
6. It damages foliage and weaken trees.
7. Many insects and fungi are more tolerant to acidic conditions and hence they can attack the susceptible trees and causes diseases.

Control of acid rain:

1. Emission of SO_2 and NO_2 from industries and power plants should be reduced by using pollution control equipments.
2. Liming of lakes and soils should be done to correct the adverse effects of acid rain.
3. A coating of protective layer of inert polymer should be given in the interior of water pipes for drinking water.

Climate change:

The earth's climate is dynamic and always changing through a natural cycle. The cause of climate change can be divided into two categories.

1. Natural causes.
2. Man made causes or artificial causes.

Few factors which are responsible for climate change on the earth is

1. Variation in the earth's orbital characteristics
2. Atmosphere carbon dioxide variation
3. Volcanic eruptions
4. Variation in solar output
5. Ocean currents.

The man-made activities are upsetting the environment. Green house gases are increasing in the atmosphere resulting in increase in the average global temperature. Due to anthropogenic activities huge number of toxic gases and chemicals are contaminated to the atmosphere leads to the formation of acid rain and ozone layer depletion.

Global warning or green house effect: Green house effect is defined as "**the progressive warning up of the earth's surface due to the effect of man made CO_2 in the atmosphere"**. The earth and its atmosphere to remain at a constant temperature, incoming solar energy must to balanced by an equal amount of outgoing energy. Everyday, the earth is warmed by the sun; light strikes the earth and heat the surface. Heat is then slowly radiated back into the atmosphere. This heat escapes from the earth's

atmosphere and returns to space. Thus, an energy balance is setup. This balance can be altered by changes in the gas composition of the air. Naturally occurring CO_2 absorb heat (IR radiation) escaping from the earth's surface and radiates it back, thus helping to maintain the earth's temperature. Any anthropogenic activity, increase the concentration of CO_2 which slow down the escape of heat.

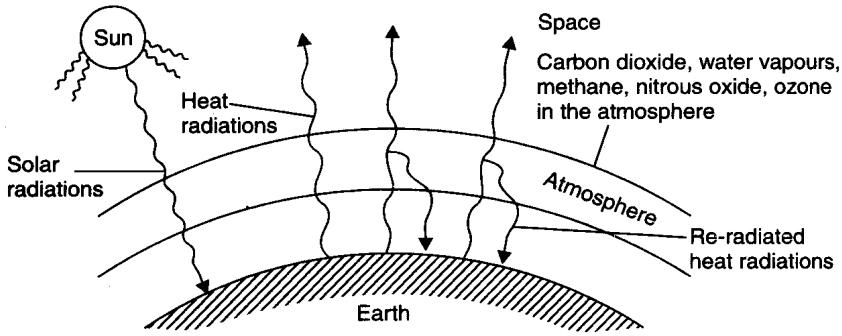


Fig. Global warming

The diagram explains the possible element of a global temperature increases. But only CO_2, other gases like ozone, methane, nitrous oxide, chlorofluorocarbon and water vapour also cause the green house effect. The two predominant green house gases are water vapours, which are controlled by hydrological cycle and carbon dioxide which is controlled by the global carbon cycle. While the levels of water vapour in the troposphere have relatively remained constant, the levels of carbon dioxide have increased. Other gases like methane, nitrous oxide and chlorofluorocarbons levels have increased due to human activities. Deforestation has further resulted in elevated levels of carbon dioxide due to non-removal of carbon dioxide by plants through photo synthesis.

Impact of enhanced green house effect:

1. Global temperature increases: The earth temperature will rise between 1.5 to 5.5^0C by 2050.
2. Rise in sea level: With the increase in global temperature sea water will expand. Heating will melt the polar ice sheets and glaciers resulting in further rise in sea level.
3. Effects on Human health: The global warming will lead to changes in the rain fall pattern thereby affecting the distribution of water borne diseases like malaria, filariasis, elephantiasis etc.

Measures to check global warming: In order to decrease the global warning the following steps will be important:

1. Reduce use of CFC and fossil fuel.
2. Use energy more efficiently
3. Shift to renewable energy sources.
4. Increase Nuclear power plants for electricity production.
5. Shift from coal to natural gas
6. Trap and use methane as a fuel.
7. Adopt sustainable agriculture
8. Stabilize population growth
9. Plants more trees
10. Remove atmospheric CO_2 by utilizing photo synthetic algae.

Ozone layer depletion:

Ozone layer filters out harmful ultraviolet radiations from the sunlight and thus protects various life forms on the earth. Ozone is a form of oxygen. The molecule of oxygen contains two atoms where as ozone contains three oxygen atoms. In the stratosphere ozone is continuously created by the absorption of short wave length ultraviolet radiations. It decomposes molecular oxygen into atomic oxygen by photolytic decomposition.

$$O_2 + h\gamma \rightarrow O + O$$

The atomic oxygen rapidly reacts with molecular oxygen to form ozone.

$$O + O_2 + M \rightarrow O_3 + M^*$$

M is a third body necessary to carry away the energy released in the reaction. Ozone formed is distributed itself in the stratosphere and absorbs harmful ultraviolet radiations and is continuously converted back to molecular oxygen.

$$O_3 + h\gamma \rightarrow O_2 + O$$

The net result of the above reactions is an equilibrium concentration of ozone. This equilibrium is disturbed by reactive atoms of chlorine, bromine etc., which destroy ozone molecules and results in thinning of ozone layer called ozone hole. Three major activities could destroy the ozone layer.

i. The use of spray cans and refrigerants that contain Freon gas.

ii. High flying supersonic jets.

iii. The detonation of nuclear weapon.

In many developing and developed countries, two Freon are used.

i. Freon – 11 (trichloromono fluoromethane) is banned by many countries

ii. Freon – 12 (dichloro difluoromethane) is still used in refrigerators. Air conditioners and freezers. The effects of freons on Ozone layer was occurred through two steps ie., photo dissociation and reduction of ozone as follows

Step I - Photo dissociation of Freon 12

$$CCl_2F_2 \xrightarrow{uv-light} CClF_2 + [Cl]$$

Step II - Ozone depletion or hole formation

$$[Cl] + O_3 \rightarrow ClO + O_2$$

$$ClO + [O] \rightarrow [Cl] + O_2$$

$$ClO + O_3 \rightarrow ClO_2 + O_2$$

Aircrafts and jet engines also produces NO in the stratosphere which also reduce the ozone is as follows.

$$NO + O_3 \rightarrow NO_2 + O_2$$

$$NO + O_2 \rightarrow NO_2 + [O]$$

Due to this effect, leads to the formation of permanent depletion in ozone layer. The effects of ozone layer depletion are penetration of more amount of uv-light which produces skin burns and skin cancer, kills lower fauna and flora. It affects photosynthesis process, cause mutations and may stop growth. However it also affects the climate change due to the elimination of stratospheric ozone. Yield of vital crops like corn, rice, soybean, bean, cotton, and wheat will decrease. Degradation of paints, plastics and other polymer material will results in economic loss due to effects of UV radiation resulting from ozone depletion.

Control measures:

1. The release of CFC'S must be controlled and efforts to be made to avoid ban the companies manufactures CFC.

Research alternative to substitute the CFCs for its applications but without ill-effects

Control of air pollution: The various ways of preventing air pollution are given below:

1. Smoke can be reduced during the combustion of fuel. Correct method of burning, allowing required amount of air and using high temperature will considerably reduce the amount of smoke. Uniform quantity of air and fuel supply will reduce the smoke considerably.
2. Smoke from automobile emissions can be considerably reduced by fixing catalytic converters in the exhausts pipes.
3. The installation of tall stacks or chimneys in industrial gas outlets prevents the accumulation of smoke in the ground level.
4. Cottrell electrostatic precipitator is a device used in industrial gas outlets which makes the smoke to settle as carbon particles.
5. By using extraction ventilation method is industries which remove the dust. There are other methods of dust removal which make use of devices such as bag filter, cyclone dust separators, centrifugal separators etc.,
6. Sulphur dioxide gas pollution can be reduced by removing sulphur before combustion or removal of SO_2 gas by passing through various absorbents like alkalized alumina, activated carbon, limestone powder, liquid ammonia, lime water etc.,

$$2NH_4OH + SO_2 \rightarrow (NH4)_2SO_4 + H_2$$

$$Ca(OH)_2 + SO_2 \rightarrow CaSO_4 + H_2O$$

7. Acid and chemical fumes can be absorbed through a tower filled with coke powder and current water is applied at the top.
8. Proper planning in industrial areas is a must for avoiding pollution. The residential quarters should be built leaving comfortable gap between industrial area and residential area. This kind of planning is known as industrial zoning.
9. Air Pollution can be considerably reduced by avoiding fossil fuels like coal or petroleum. Products and making much use of hydroelectricity, nuclear power, solar energy etc.
10. Growing more vegetation and protecting the existing forests will considerably clean the environment. Plants use carbon dioxide for photosynthesis and evolve oxygen. Hence the help to reduce the carbon dioxide level in the atmosphere. Many plants also absorb notable amount of other gases like H_2S, NO, N_2O, NO_2,

etc. The vegetation and forest act like a sieve in settling dust particles which passes through them.

WATER POLLUTION

Definition: Water pollution is defined as the addition of impurities or foreign substances to water, that alter its physical, chemical or biological characteristics and make it not suitable for drinking and domestic purposes.

Sources of water pollution: Water is polluted by point sources and non-point sources. Point sources are specific sites which directly discharge effluents to water sources.

Major point sources of water pollution are industries, nuclear and thermal power plants, underground coal mines and offshore oil wells.

Non – point sources are not specific sites which are scattered. Surface run-off from agricultural fields, over flowing drains; rain water sweeping roads and fields, atmospheric deposition etc. are the non-point sources of water pollution. The main sources of water pollution are as follows:

Community waste: It includes discharges from houses, commercial and industrial establishment connected to public sewage system. The sewage contains human and animal excreta, food residue, cleaning agents, detergents and other wastes. It is always rich in organic matter, bacteria and other wastes. It is always rich in organic matter, bacteria and other biological agents. These agents are decomposed by microorganisms. The process of decomposition of organic matter present in water by microorganisms using oxygen is called putrification or putrescibility. Increase in concentration of organic waste leads to lack of oxygen which kills fishes and other aquatic life. Deoxygenation of water causes anaerobic bacteria to produce foul smelling gases.

Industrial Waste: The major sources of water pollution are the effluent discharge from industries in water bodies. Various industries are chemical and metallurgical industries, food processing plants, textile, paper and sugar mills, rubber industries, plastic industries, oil refineries and organic pollutants which prove highly toxic to living beings.

Inorganic pollutants: It includes fine particles of different metals, chlorides, sulphates, cyanides, thiocyanate, oxides of iron, copper, cadmium, mercury and chromium, acids and alkalis.

Organic pollutants: It includes cellulose fibres, carbohydrates, proteins, oils, fats, phenols, naptha, organic acids, aromatic compounds and antibiotics. Some important sources of industrial Pollutants are given in table.

Table: Sources of Industrial Pollution

Type of Industry	Inorganic pollutants	Organic pollutants:
Mining	Mine waste: Chlorides, various metals, ferrous sulphate, sulphuric acid, hydrogen sulphide, ferric hydroxide, surface wash offs, suspended solids, chlorides and heavy metals.	---
Iron and Steel	Suspended solid, iron cyanide, thiocyanate, sulphides, oxides of copper, chromium, cadmium and mercury	Oil, phenol and naptha
Chemical plants	Various acids and alkalis, chlorides, sulphates, nitrates of metals, phosphorous, fluorine, silica and suspended particles	Aromatic compounds, solvents, organic acids, nitro compounds, dyes etc.
Soap and detergents	Tertiary ammonium compounds and alkalis	Fats and fatty acids, glycerol, poly phosphates, sulphonated hydrocarbons.
Food processing	-	Highly putrescible organic matter and pathogens
Paper and pulp	Sulphides, bleaching liquors	Cellulose fibres, bark, wood, sugars, organic acids.

Agricultural Sources: Artificial fertilizers and pesticides have become potential sources of water pollution. Pesticides include insecticides, fungicides, herbicides, nematicides, rodenticides and soil fumigants. It contains chemicals such as chlorinated hydrocarbon, organophosphates, metallic salts, carbonates, thiocarbonates derivates of acetic acid etc.

Ground water pollution: Ground water is less prone to pollution as the soil mantle through which water passes helps to retain various contaminants due to its cation exchange capacity. However there are a number of potential sources of ground water pollution. Septic tanks, industry (Textile, Chemical, and tanneries), deep well injection, mining etc., are mainly responsible for ground water pollution. Ground water pollution with arsenic, fluoride and nitrate possess various health hazards.

Surface water pollution: The major sources of surface water pollution are

1. **Sewage:** pouring the drains and sewage in fresh water bodies causes water pollution. The problem is severe in urban areas.
2. **Industrial effluents**: Industrial waste containing toxic chemicals, acids, alkalis, metallic salts, phenols, cyanides, ammonia, radioactive substances etc., are sources of water pollution. They also cause thermal pollution of water.
3. **Synthetic detergents**: Synthetic detergents used in washing cleaning produce foam and pollute water.
4. **Agrochemicals:** Agrochemicals like fertilizers (containing nitrates, and phosphates) and pesticides are (insecticides, fungicides, herbicides) washed by rain water and pollute the water bodies.
5. **Oil**: Oil spillage into sea-water during drilling and shipment polluted
6. **Waste heat:** Waste heat from industrial discharges increases the temperature of water bodies and affects distribution and survival of sensitive species.

Effects of water Pollution: Important pollutants of water pollutions are

Pathogens: Wastewater contains many pathogenic and non-pathogenic microorganisms. The wastewater contaminates with water resources leads to spreading of water borne diseases like cholera, dysentery, typhoid and jaundice.

Chemicals:

Fluoride: It is essential for protection against dental caries and weakening of bonds, the higher levels leads to flourosis and damage to spinal cord.

Arsenic and Lead: It causes vascular diseases, skin cancer, liver and nervous system damage.

Hazardous chemicals: Dioxin, DDT, Xylene causes heart and skin diseases.

Radioactive wastes: Nuclear power plants emit radioactive materials. They produce lungs cancer and destruction of DNA.

Nutrients:

The organic materials can cause the eutrophication. Nitrogen contamination can cause the health problem and blue-body syndrome.

Oxygen demanding waste: Organic matter present in water is decomposed by micro-organisms. For this degradation dissolved oxygen in water is consumed. Dissolved oxygen is the amount of oxygen dissolved in a given quantity of water at a particular temperature and atmospheric pressure. Amount of dissolved oxygen depends on aeration, photosynthetic activity in water, respiration of animals and plant. The saturation value of DO varies from 8-15mg/L. For active fish species 5-8mg/L of DO is required whereas less desirable species like carp can survive at 3.0mg/L of DO. Lower DO may be harmful to aquatic animals especially fish population. The higher amounts of organic waste increase the rate of decomposition and oxygen consumption which decreases the DO content of water. The demand of oxygen is directly related to increasing input of organic wastes and is expressed in terms of Biological Oxygen demand (BOD). BOD is a measure of oxygen required by aerobic decomposers for the biochemical degradation of organic materials in water. Higher the BOD values indicate low DO content of water.

Nitrogen and Phosphorus compounds: Addition of compounds containing nitrogen and phosphorus helps in the growth of algae and other plants. This algal species quickly complete their life cycle and die which leads to increase in organic content in water bodies. These organic matters undergo decomposition by using dissolved oxygen present in the water. Due to decomposition of organic matter, the dissolved oxygen content decreases in water bodies which is essential for aquatic fauna. Excess growth or decomposition of plant material will change the concentration of CO_2 which will further change pH of water. Change in pH, oxygen and temperature will change many physical and chemical characteristics of water.

Toxic compounds: Pollutants such as heavy metals, pesticides, cyanides and many other organic and inorganic compounds are harmful to aquatic organisms. Some pesticides penetrate into the bodies of organisms through the medium. Example: DDT is not water soluble. But it has affinity for body lipids. These substances tend to accumulate in the organisms body. This process is called “bioaccumulation”. The concentration of these toxic substances builds up at successive levels of food chain. This process is called biomagnifications. Following is the example of biomagnification of DDT is aquatic food chain.

Component	**DDT concentration(PPM)**

Birds	10.00
↑	↑
Neadle fish	1.0
↑	↑
Minnows	0.1
↑	↑
Zooplankton	0.01
↑	↑
Water	0.000001

Toxic substances in water affect human health. Some heavy metals like lead, mercury and cadmium cause various types of diseases. Lead is as accumulating poison, mainly in the bone and gets circulated into the body through the blood system. The concentration of lead is natural waters increases due to man-made activities. Arsenic pollution is mainly caused by pesticide industries. Arsenic chemicals can cause skin cancer and hyper pigmentation diseases. Cadmium chemicals can cause bones disease. It also affects the liver, kidney, lungs and thyroid. Nitrate present in excess in drinking water causes blue baby syndrome. This disease develops when a part of haemoglobin is converted into non-functional oxidized form.

Control of water pollution: It is easy to reduce water pollution from point sources by legalization but it is difficult to prevent water pollution from non point sources. The following points may help in reducing water pollution from non-point sources.

1. Industrial wastes and effluents should be treated in order to reduce their toxicity. In addition, proper disposal systems should be put in place to prevent contamination of water bodies.
2. Limited use of agrochemicals like pesticides and fertilizers which will reduce their run-off and leaching. Avoid use of agrochemicals on sloped land.
3. Use of nitrogen fixing plants to supplement the use of fertilizers.
4. Adopting integrated pest management to reduce the use of pesticides.
5. Prevent run off of manure. Divert such run-off to basin for settlement. The nutrient rich water can be used as fertilizer in the agricultural fields.

6. Separate drainage of sewage and rain water should be provided to prevent overflow of sewage with rain water.
7. Planting trees which reduce pollution and also prevent soil erosion.
8. By encouraging industries to reduce or eliminate the use of toxic chemical and hazardous materials.

For controlling water pollution from point sources, treatment of wastewater is essential before being discharged. Parameters which are considered for reduction in water are: Total solids, biological oxygen demand (BOD), chemical oxygen demand, nitrates, and phosphates, oil and grease, toxic metals etc. Wastewater should be properly treated by primary and secondary treatments to reduce the BOD, COD levels up to the permissible levels for discharge. Advanced treatment for removal of nitrates and phosphates will prevent eutrophication. Proper chlorination should be done to prevent the formation of chlorinated hydrocarbon and disinfection should be done by ozone or ultraviolet radiations.

SOIL POLLUTION

Soil pollution is defined as the addition of domestic waste, industrial and commercial wastes, chemical fertilizers, and pesticides etc., which affect physical, chemical and biological properties of the soil and reduces its productivity.

Sources of Soil pollution

Soil pollution occurs directly by dumping and disposal of wastes application of agrochemicals etc. The main soil pollutants are as follows:

Industrial Waste: Both solid and liquid wastes of industries are dumped on the soil. These wastes consist of number of toxic chemicals along with non – biodegradable materials. (Mercury, lead, copper, zinc, cadmium, cyanides, thiocyanates, Chromates, acids, alkalis and organic substances). This non – biodegradable material accumulated in the soil reduces its filtering capacity and causes soil pollution.

Urban Waste: Both domestic and commercial wastes are known as urban waste. It contains rubbish materials like papers, fibres, plastics, glasses, bottles and other discarded product.

Agricultural Practices: In modern agriculture practices, insecticides, fungicides, herbicides, fertilisers are used. This causes accumulation of these chemicals in the soil. Chemical pesticides are used by the former to protect the crops from the pests and

diseases. However, some pests and diseases have the ability to resist the chemical sprays. So, the former needs to spray the crops with stronger pesticides. Such application of chemicals such as aldrin, endrin, dieldrin, endosulphan, Benzene hexa chloride (BHC) and DDT causes soil contamination and makes entry into the food chain. The accumulation of pesticides in the food chain from the lower to the higher trophic level causes more effects and disturbs the entire environment.

Farm House Waste: Increase in population of cows, cattle, pigs and poultries in the farm house which leads to pollution of soil. Their focal matter mainly consists of phosphates and nitrate which causes undesirable effects in the soil texture.

Radioactive Waste: Storage and disposal of radioactive waste from nuclear power plants penetration and accumulation of radioactive materials and cause soil pollution. The radioactive nuclides such as strontium – 90, iodine – 129 and 131, Caesium – 137 and 144, ruthenium – 106, barium – 140 and lanthanum – 140 are deposited on the top soil and emits continuously the gamma radiation which causes dangerous effects to the human beings.

Biological agents: Large quantity of human, animals and birds excreta are dumped on the soil which mainly consist of dangerous biological agents causes soil pollution.

Effect of Soil pollution:

Agricultural practices produce hazardous pollutants to air, water and soil. Pollutants are added by wind and burning of any fuel which releases their residues on the soil. Heavy metal addition of soil can affect soil fertility and agricultural productivity. The soil acts as a long term sink for heavy metals such as zinc, copper, nickel, cadmium etc. The heavy metals such as copper, zinc and molybdenum are essential trace elements for plants and animals by excessive concentration can reduce the soil fertility. Metals like Pb and Cd can have dangerous effects on human and animals health if they are allowed to accumulate in the food chain.

Sewage sludge from the textile industry contains high concentration of elements of B, Pb, Cd, Cu and Cr. Disposal of these wastes into river decreased rice production and was a potential cause of environmental degradation. Air pollution from the exhaust of cars driving through tea plantation areas increased the lead content of the soil. This concentration of lead was highest in the soil nearest the main road. Traditional gold

mining and extraction was a significant cause of pollution for lowland rice around the mining area and increased the mercury content in rice.

Industrial metallic contaminants (Mg, Pb, Zn, As, Cd, Cr, Na, K and Cu) destroy bacteria and beneficial microorganisms present in the soil. Heavy metal is converted as their phosphates compounds which non – biodegradable poison. This heavy metal phosphate compounds are accumulated in the soil for a long time and destroy the living organism.

Severe agricultural crop damage is caused by high acidity and alkalinity of the soil coming from chemical industries. About 30 % of irrigated land of the world is affected by salinity of the soil and water logging. Products of industries such as synthetic fibres, plastics and waste paper when consigned to incineration, produce toxic vapour leads to air pollution. When discarded plastic materials, textiles, packages and togs of poly vinyl alcohol are burnt in the soil, they emit toxic gases like HCl fumes, SO_2 and NO_2 etc.

The disposal of cadmium from mining, metallurgy, chemical and electroplating industries causes chronic poisoning, formation of kidney stones and sometimes failure of kidneys

Accumulations of methyl mercury compounds are much more toxic than other forms of mercury. It causes neurological problems.

Effect of Biological agents: Some organism help in maintenance of pollutants. Soil acts as a potential carrier of microbial growth, non – biodegradable matters and pathogenic microorganisms which can endanger human health and life. Few examples are follows:

Pathogenic soil bacteria are chronic diseases carriers which are transmitted from man to soil and vice versa causing cholera, typhoid, bacillary dysentery, paratyphoid fever. Etc. Files which breed or get in contact with the contaminated soil become carriers of diseases organisms. Pathogenic soil bacteria are mycobacterium, salmonella typhosa, leptospira and pasteurella which pone a serious threat to man's health. They cause infections of intestinal tract like amoebic dysentery, cholera, typhoid, polio and hepatitis. Many of these are endemic to particular population.

Control of soil Pollution:

1. Effluents should be properly treated before discharging them on the soil

2. Solid waste should be properly collected and disposed off by appropriate method
3. From the waste, recovery of useful product should be done.
4. Bio degradable organic waste should be used for generation of bio gas.
5. The use of chemical fertilizers and pesticides should be minimized as far as possible
6. Cattle dung should be used for methane generation. Night-soil (human faces) can be used in the biogas plant to produce inflammable methane gas.
7. Microbial degradation of biodegradable substances is one of the scientific approaches for reducing soil pollution.

MARINE POLLUTION

Definition: Marine pollution is defined as the undesirable changes produced in the coastal sea water and coastal land zones by the industrial effluents, domestic sewage, oil spills etc.

Source of marine pollution: The industrial effluents are dumped into the sea through some water ways like river. The industrial waste contains lead, copper, zinc, arsenic barium, chromium, antimony, manganese tin and mercury. Apart from various metals, it also consists of toxic chemicals such as acids, alkalis, pesticides, distillery wastes, tannery wastes, mine drainage, waste of paper, soap, sugar and radioactive wastes which greatly pollute the coastal sea waters and affect the interior part of the sea water. The rivers passing through big cities are highly polluted and carry the domestic sewage and mix with the sea water. The contamination water is mainly due to the leakages in oil tankers during transportation, oil production and oil tankers disaster.

Effects of marine pollution: The major effects of marine pollution are directly affects the marine organisms (fisher) and then to human system through food chain.

Zooplankton

Phytoplankton Sea Organisms

Small fishes

Nutrients

Man

Fish dies

Edible fishes

Food chain

1. The pollution of sea water causes ecological imbalance in the marine environments. Many of the sea organisms develop resistances to pollutants where as some of them get destroyed.
2. Reduction in photosynthetic rate: owing to the high concentration of pollutants found in ocean ecosystem because of marine pollution, the water becomes turbid decreasing the penetration of light which reduces the rate of photosynthesis of plants.
3. Disposal of nutrients rich waste such as nitrogen, phosphorus, etc., increases the growth of phytoplankton and algae estuaries and valleys further depleting the concentration of oxygen content in the marine ecosystem.
4. Pathogens generated from sewage contaminate the coastal swimming areas and seafood, and hence spread diseases such as cholera typhoid, and fatal diseases.
5. The pollutants in the air gets settled or washed down by rain. The contamination of marine due to thermal power plants, petroleum refineries and nuclear reactors which causes thermal pollution. So the qualities of water are affected.
6. The coastal lands are polluted by the insecticides, pesticides, fertilizers and other agricultural wastes. Pollution of coastal waters make the beaches contaminated and mixed into the ground water systems and destroy the quality of ground water.

Control Measures:

1. Toxic pollutants from industries and sewage treatment plants should not be discharged in coastal waters.
2. Coastal waters should be periodically analyzed for detecting pollution levels

3. Soil erosion in the coastal land has to be stopped by using specific techniques.
4. The oil pollution in the marine environment has to be protected.
5. The public beaches have to be maintained in a neat and tidy manner making use of latest clearing techniques and man power.
6. Run off from non-point sources should be prevented to reach coastal areas.
7. Dumping of toxic, hazardous waste and sewage sludge should be banned.
8. Development activities on coastal area should be minimized.
9. Ecologically sensitive coastal areas should be protected by not allowing drilling.
10. Disposal of poisonous substances into the sea must be stopped by enforcing strict laws.

NOISE POLLUTION

Noise pollution is defined as an unwanted sound dumped into the environment. Noise pollution is the unpleasantness of sound produced by the massive industrialization that can affect the health of human beings.

The quality of unpleasantness of sound depends upon the following factors.

1. The intensity of the sound waves
2. The frequency of the sound waves
3. The time of exposure of sound waves.
4. Intermittence of sound waves.

The loudness is the source of sound with a combination of intensity and frequency. It can be measured by the unit decibels. The optimum noise levels prescribed are ≈ 45 dB. The noise level above 80 bB is hazardous to health and cause noise pollution.

Sources of Noise pollution:

Natural sources – Ex. Thunder

Man made sources: Ex. Noise from buses, cars, automobiles, trucks, industries, trains, aeroplane, TV, radio, barking of dogs, shouting etc.,

Source of noise may be classified into 3 types:

1. Industrial noise: Noises from machines of industries and mills.
2. Transport noise: It involve mainly road traffic noise, rail traffic noise and aircraft noise.

3. Neighbourhood and domestic noise: It involves the noise from TV, radio, telephone, washing machine, fans, barking of noise, car alarms and speakers etc.

Diwali is a festival of lights; traditionally people of all ages enjoy firecrackers. Some accidents do occur every year claming a few livers. Besides, noise generated by various fire crackers is beyond the permissible noise levels of 125 decibels as per the environmental rules, 1999. The natural sources like thunder or certain kind of natural disasters can produce noise pollution. The domestic noise produces the major noise pollution, especially in the urban areas mainly due to the automobiles. Community noise also leads to noise pollution.

Effects of Noise:

Noise causes the following effects.

1. **Interferes with man's communication**: In a noisy area communication is severely affected.
2. **Hearing damage**: Noise can cause temporary or permanent hearing loss. It depends on intensity and duration of sound level.
3. **Neurotic disorders**: Exposure of loud noise for a prolonged period of time can cause some kind of nervous disorder like emotional stress, ill temper, irritation and tension. Neurosis is a disease due to the breakdown in the nervous system which is caused by noise pollution.
4. One of the common physical disorders due to prolonged loud noise or sound can increase the blood pressure in human beings. The disorder like abnormal sweating, omitting sensation are also produced due to noise pollution.
5. **Mental depression**: Continuous exposure to high noise level can result increased mental depression rates.
6. **Speaking and hearing ability**: The noise level above 60dB affects the speaking ability. Prolonged exposure to noise level above 100dB for a long period can cause permanent hearing disability.
7. **Sleep**: Continuous exposure to noise level above 80dB can also affect the normal sleep of human beings. The reduction in the depth, quality and quantity of sleep can cause physical disorders like increase in blood pressure etc.

8. Noise pollution not only affects human being but also birds and animals. Birds change their habitat due to noise pollution. Noise pollution makes them also physically and mentally sick.

Control measures of Noise pollution:

1. Introduction of sound proof tiles which prevent sound from bouncing back.
2. Reduction in sources of noise: Sources of noise pollution like heave vehicles and old vehicles may not be allowed to ply in the populated areas.
3. Noise making machines should be kept in containers with sound absorbing media. The noise path will be in interrupted and will not reach the workers.
4. Proper oiling will reduce the noise from the machinery.
5. Use of sound absorbing silencers: Silencers can reduce noise by absorbing sound. For this purpose various types of fibrous material could be used.
6. Even in bigger cities, the plantation of trees on road sides as well as parks can reduce. Planting more trees having broad leaves.
7. Unwanted usage of public address systems using speakers for entertainment in public areas should be prohibited.
8. Silence Zones, like hospitals, schools, colleges, etc., should be strictly protected from domestic noise pollution.
9. Government shall impose fine on noise polluters.
10. Through law: Legalization can ensure that sound production is minimized at various social functions. Unnecessary born blowing should be restricted especially in vehicle congested areas.

THERMAL POLLUTION

Thermal pollution is defined as the drastic change in the water temperature due to the addition of waste heat or cool water to the water body or change in the amount of solar radiation.

Source of Thermal pollution: Water is used to cool the machinery in their plants and is returned to the water body at a higher temperature. Heat producing industries, thermal power plants, nuclear power plants, refineries; steel mills are the major sources of thermal pollution. They are as follows:

1. The nuclear reactor produces lot of heat and traces of radioactive nucleus. Radiation from the nucleus in water raises the temperature.
2. Coal fired power plant utilise the water for condenser. This plant discharges the water at high temperature.
3. Domestic Sewages has always higher temperature. It is not only increasing the temperature of water body, also creates enormous effects on aquatic system. As temperature increase, the dissolved oxygen decreases which make the water body under anaerobic condition and releases foul and toxic gases in water.
4. The direct exposure of sun light on the water surface is greater then water absorbs more amount of heat and rises the temperature of the water body.
5. In various industries, water acts as ac cooling agent which discharge hot water to water bodies makes thermal pollution.
6. Soil erosion makes the water muddy, which increase the absorption of sun light. Thus the temperature of the water is increased.

Effects of thermal pollution: The increase in temperature of the water system affects the physical property of water.

1. Increase in temperature of the water system affects its viscosity, density, vapour pressure, surface tension, gas solubility and diffusion rate.
2. The sedimentation of suspended particles decreases.
3. Increase in temperature leads to increase of evaporation rate.
4. Increase in temperature reduces the taste of water.
5. The reaction rate increases with increase of temperature. If different reactive pollutants are present in water bodies which react together to produce toxic substances (Secondary pollutants).
6. Thermal pollution can lead to the fall of population of one species and the growth of another species.
7. Temperature change in aquatic system can affect the behaviours, reproduction cycle, respiration rates and many of the physiological processes of aquatic organisms including fishes.
8. Fish migration is affected due to formation of various thermal zones.

9. The dissolved oxygen content of water is decreased as the solubility of oxygen in water is decreased at high temperature.
10. Toxicity of pesticides, detergents and chemical in the effluents increases with increase in temperature.
11. The metabolic activities of aquatic organisms increase at high temperature and the requirement of dissolved oxygen increases, where as oxygen level decreases with increase in temperature pollution.
12. Higher temperature promotes the blue – green algal blooms which affect the aquatic food chain. This growth inhibits the growth of other aquatic organism and produces foul odour.

Control of thermal pollution:

The important way to control thermal pollution is to remove threat from the waste water using cooling systems and then it can be allowed to mix with the water bodies like river, lake or sea.

1. In popular cooling systems adopted to treat the thermally polluted water is to use cooling ponds, spray ponds or cooling towers.
2. In cooling ponds the heat is reduced by natural evaporation process.
3. In spray ponds, the hot water from the condenser is sprayed through the number of nozzles. The nozzles are used to convert the water into fine droplets which provide large surface area. Therefore, the heat transferred to atmosphere.
4. In wet cooling towers, the hot water is direct contact with continuously flowing air. The hot water is flowing downwards and air takes the heat from the hot water.
5. In dry cooling towers, cooling air flowing around the pipes and takes the heat from the hot water flowing inside the pipe. There is no direct contact between cooling air and hot water.
6. In artificial lake, the hot water is discharged in the one end and cooled water is taken from the other end. The temperature of the hot water reduced slowly.
7. Recycling of heat energy wherever possible for purpose like heating the room etc.
8. Maintaining the heat requirement process optionally hence over heating and wastage of heat leading to fuel consumption etc., can be minimized.
9. Maximum utilization of thermal energy present in exhaust and industrial water

NUCLEAR HAZARDS (OR) RADIOACTIVE POLLUTION (OR) NUCLEAR POLLUTION

Definition: The addition of unwanted natural or artificial radioactive materials to the environment which causes dangerous effects to human being, animals and plant is called radioactive pollution or nuclear hazards.

Radioactive materials degenerate naturally to non-radioactive materials. Each radioactive substance has its own half life period. They undergo natural radioactive decay in which, high energy radiations or both, at a fixed rate until a new stable isotope is formed.

The isotopes release energy either in the form of gamma rays or ionization particles ie., alpha and beta particles. Gamma rays one high energy electromagnetic radiation. Alpha particles can be blocked by a piece of wood or a few millimetre of aluminium sheet. Gamma rays can be stopped by can create wall but not blocked by paper or wood. Some of the radioactive elements causes radioactive pollution are Curium -245, Caesium – 135, lead – 210, Polonium – 210, plutonium – 226, radon – 222, Thorium – 230 and uranium – 235.

Sources of the Radioactive Pollution: There are two types of sources

1. Natural sources and
2. Artificial or man-made sources

Natural Sources: Naturally occurring radioactive isotopes (Radon -222, Thorium – 232, uranium – 238 and potassium – 40) present in the environment as well as various living organisms in soil, rocks, air, water and food. Up to some extent cosmic radiation also contains some amount of natural radioactivity, from the space, volcano eruption, earth quake etc.

Man – made Sources: Cell phones, TV sets, luminous clocks, nuclear power plant, Heave water plant, nuclear accidents, X-rays, diagnostics kits, test laboratories. In military, there is liberation of radioactive materials after the accident with nuclear weapon. In non – military cause include

1. Accident due to handling or transportation of radioactive material.
2. Accident due to industrial, scientific or medical facilities
3. Breakdown of satellites and aeroplane crash

4. Improper storage of nuclear waste materials

Effects of radioactive pollution:

1. Ionisation radiations can affect living organisms by causing harmful changes in the body cells and also changes in genetic level.
2. Genetic damage is caused by radiations, which include muta-rotations in the DNA, thereby affecting genes and chromosomes. This damage is transmitted up to several generations.
3. Somatic damages include burns, miscarriages, eye cataract, and cancer of bone, thyroid, breast, lunges and skin.
4. Population movements
5. Area Conflagration
6. Destruction of infrastructure
7. Radioactive isotopes enter the environment during mining of Uranium. It affects the crops growth and ultimately human beings.
8. Radioactive nuclides enter into the water bodies or ground water coming in contact with the contaminated soil or rock.
9. Radio active iodine I^{131} accumulates in thyroid gland and causes cancer.
10. Strontium -90 accumulates in the bones and causes leukaemia or cancer of bone marrow.

Control of Nuclear pollution:

1. Sitting of nuclear power plants should be carefully done after studying long term and shorts term effects.
2. Proper disposal of water from laboratory involving the use of radio isotopes should be done.
3. Proper isotopes should be implemented to the workers to take care of their health.
4. In nuclear power station, emission of radio isotopes should be controlled by regular monitoring and preventive measures.
5. Proper disposal of radioactive waste.
6. Properly trained persons only allowed to operate the reactors to control the radiation emission

NUCLEAR ACCIDENTS AND HOLOCAUST

Nuclear Accidents

The most serious hazard to human and environmental health from the nuclear accident is the release of large amounts of nuclear energy and radioactive products into the atmosphere.

Types of Nuclear Accidents

a) **Nuclear test**: Nuclear explosions, carried out in underground, cause settling down the radioactive materials on the earth's surface and radioactive particles, radioactive rays into the atmosphere.

b) **Nuclear power plant accidents**: the release of radiation occurs during the accidents. The nuclear power plant located in the seismic vulnerable area may cause nuclear accidents.

c) **Improper disposal of radioactive waste:** It is another source of accident. Drums stored underground can rust and leak radioactive materials into water, land and air.

d) **Accident during transport**: Trucks carrying radioactive wastes or fuels are involved in frequent accidents.

e) **Core melt down:** The major accident at a nuclear power plant is a "core melt down.

Effect of Nuclear Radiation

1. Radiations may break chemical bonds such as DNA in cells.
2. Exposure at low dose of radiation (100 – 250 rads), people do not die, but begin to suffer from fatigue, vomiting and loss of hair.
3. Exposures at higher dose of radiation (400 – 500 rads) affect bone marrow, blood cells, natural resistance and blood to fail clot.
4. Exposure at very high dose of radiation (10,000 rads) kills the organisms by damaging the tissues of heart, brain.

Nuclear Holocaust

It means destruction of biodiversity by nuclear equipments and nuclear bombs. In a holocaust, a large number of living beings are totally destroyed. Usually, these kinds of destructions are happened in a nuclear war.

Effect of Nuclear holocaust

1. **Nuclear Winter**: Due to nuclear explosions, a process known as opposite to global warming will occur. This is called nuclear winter.

   Effect of nuclear winter: Lowers the global temperature, even in summer the temperature will be at around freezing temperature. Crop productivity will be reduced causing famines and human sufferings.
2. It ignite all combustible material, destroy all the living beings, material crushing, destruction of home.

Example: Nuclear war: Japan, Hiroshima and Nagasaki are the examples of nuclear holocaust, which had happened at Second World War.

Control measures

1. Suitable precautions are to be taken and training must be given to people for handling these materials to avoid accident.
2. Constant monitoring of the radiation level has to be carried out, limit exposure to the workers.
3. Regular checks and control measures are done by Atomic Energy Regulatory Board under the Department of Atomic Energy.

Role of an individual in prevention of pollution:

Man is the creator as well as the destructor of the environment. For man's comfort, the natural and the man-made environments are essential. But he has to strike a balance between them judiciously with out exploiting much of the natural environments. Urbanization, industrialization, construction of dams, destruction of the natural habitats, deforestation and population growth are some of the factors developed by human beings that affects environment to a greater extent. Each individual should change his or her life style in such a way as to reduce environmental pollution. It can be done by the following suggestions.

1. Help more in pollution prevention than pollution control
2. Use ecofriendly chemicals
3. Reduce the use of chlorofluoro carbons and polystyrene because they destroy ozone layer.
4. Use CFC free refrigerators.

5. Reduce your dependency on fossil fuels
6. Adopt and popularize renewable energy sources.
7. Improve energy efficiency. This will reduce the amount of waste energy.
8. Promote reuse and recycling wherever possible and reduce the production of waste.
9. Use mass transport system. For short-visit use bicycle or go on foot. Decrease the use of automobiles.
10. Use rechargeable batteries. It reduces the metal pollution. The solid waste generated during our manufacturing process can be use as a new material for some other processes.
11. Use organic manure instead of commercial inorganic fertilizers.
12. Don't put pesticides, paints, solvents, oils or other harmful chemical into drain or ground water.
13. Use only the minimum amount of wastes which will prevent fresh water from pollution.
14. Don't use wood materials for any building construction purpose. Plant more trees.

UNIT IV

MANAGEMENT OF ENVIRONMENTAL POLLUTION

CAUSES, EFFECTS AND CONTROL MEASURES OF SOLID WASTE

Introduction: Any substance is discarded as useless or unwanted by man and animal activities id designated as waste. These wastes are solid then the wastes are called as solid wastes. The term solid waste covers the highly heterogeneous mass of discarded materials or throwaway from the urban community (Both residential and commercial activities) as well as the more homogeneous accumulation of waste are generated by agricultural and industrial activities.

Sources of Urban and Industrial wastes:

The main sources of solid wastes are domestic, commercial, industrial, municipal and agricultural wastes.

Waste from homes (Domestic waste): Domestic waste consists of food waste and rubbish materials.

a) Garbage or food waste: These are meal, fruit or vegetable residues, fruit peels, bones, spoiled food items which decomposes rapidly (putrescible) especially in warm weather.
b) Rubbish materials: These do not decompose rapidly. These are further classified into two types.
    1. Combustible: Paper, card board, textile waste, wood items, rubber, leather, plastic containers, poly ethylene bags, egg shells, etc.
    2. Non – Combustible: Crockery, metals (aluminium and tin cans), empty glass bottles etc.,

Commercial wastes: It consists of waste paper, packing material, can, bottles, polyethylene bags, peanut shells, egg shells, tea leaves.

Industrial waste: It consists of a large number of materials including packaging material, organic waste, acids, alkalis and metals. During industrial processing large quantities of hazardous and toxic materials also produced. Radioactive wastes are generated by nuclear power plants. Solid wastes from other types of industries include

rubber, plastic, paper, glass wood, oils, paints, tars, dyes leather, ceramics, abrasives, slag, heavy metals, asbestos, and batteries.

Agricultural Waste: These include crop residues from agricultural field, farm manure etc. Example: Jute, cotton, rubber, tea, coffee, coconut, sugar cane waste, rice straw and cattle shed waste.

Pathological wastes: Animal's body, slaughter house waste (blood, pieces of meat, hair fat, bone chippings, hides, skin execrations etc.).

Demolition and Construction wastes: Demolition, construction and repair of residential, commercial and industrial buildings generate plenty of solid wastes. Example: Stones, bricks, concrete, dust plaster, electrical, plumbing and sanitary parts.

Miscellaneous waste: Street sweeping, road side litter, dead stray animals, abandoned vehicles etc.

Cause of Solid waste pollution:

The contribution of solid waste has increased manifold due to increase in urbanisation, lack of awareness, lack of public participation and poor enforcement of laws. The reasons for the rapid growth in the quantity of solid wastes are over population, affluence and technology.

a) **Over Population:** The population increases which increases the solid waste.
b) **Affluence:** As the population increases, the requirement of production and consumption also increases. With affluence there is a tendency to declare items as being in or out of fashion and promptly throw away the ones out of fashion. This results in solid waste pollution.
c) **Technology:** Growing technologies indicate that a shift in technology from the returnable packaging to non – returnable packing. Returnable glass containers or bottles are being replaced by non returnable cans, bottles, paper board and plastic containers. Packing is largely responsible for causing solid waste pollution because packaging materials like plastic bags and cans etc. are not biodegradable and persist unchanged in disposal operations such as landfills. Plastic can be recycled to make new packs but recycled plastic soon loses its strength, becomes brittle and is easily broken up by wind or rain.

Effects of Solid waste:

- Municipal solid wastes present on the roads due to improper disposal system. People clean their own houses and dispose in open place which affects the community including themselves. This type of dumping allows biodegradable materials to decompose under uncontrolled and unhygienic conditions. This produces pad smell and breeds various types of insects which cause dangerous problems to human beings.
- Industrial solid wastes are sources of toxic metals and hazardous wastes, which may spread on land and can cause changes in physicochemical and biological characteristics which affecting productivity of soils. Toxic substance may leach or percolate and to contaminate the ground water.
- In refuse and hazardous wastes are mixed with other combustible waste. This makes segregation and disposal is more difficult and risky. Various types of wastes like cans, pesticides, cleaning solvents, batteries, radioactive materials and other non-toxic materials could be recycled. Burning of these materials produce toxic gases which cause various types of diseases including cancer.
- Chocking of drains and gully pits by the solid waste result in water logging during rainy season. This water logging results in breeding of mosquitoes in the stagnant water

Solid waste management: It is a planned process of effective control of the production, storage, collection, transportation, processing and disposal of solid wastes in acceptable and economic way. Solid waste can be classified as municipal, industrial, agricultural, medical, mining waste and sewage sludge.

Indiscriminate disposal of solid wastes causes dangerous environmental effects. The main objective of solid waste management is to minimise these effects before it becomes too difficult to rectify in the future. Solid waste management is involved in following activities:

d) Collection of solid wastes
e) Disposal of solid wastes
f) Waste utilisation

Collection of Solid waste: Collection activities involve gathering of solid waste from the location and transport it into the site of disposal. There are three basic methods of collection.

a) **Community storage point:** The municipal refuse is taken to fixed storage bins and stored till the waste collection agency collects it daily for disposal in a vehicle.
b) **Kerbside Collection:** In advance of the collection time, the refuse (solid waste) is brought in containers and placed on the footway from where it is collected by the waste collection agency.
c) **Block Collection:** Individuals bring the waste in containers and hand it over to the collection staffs that empty it into the waiting vehicle and returns the container to the individuals.

Disposal of Solid Waste:

Before the solid waste is disposed, it is must be processed in order to improve the efficiency of solid waste disposal system and to recover usable resources out of the solid wastes. The processing techniques such as compaction i.e. mechanical volume reduction or incineration i.e. thermal volume reduction and manual component separation i.e. manual sorting of the waste are employed in order to increase the efficiency of solid waste management. Due to heterogeneity of the city refuse, it is important to select the most appropriate solid waste disposal method keeping in view the following objectives.

a. It should be economically viable i.e. the operation and maintenance costs must be carefully assessed.
b. It should not create a health hazard.
c. It should not cause adverse environmental effects.
d. It should not be aesthetically unpleasant i.e. it should not result in offending sights, odours and noises.
e. It should preferably provide opportunities for recycling of materials.

The methods of disposal commonly used are as follows:

Salvage or Manual Component Separation: Before disposal, the manual separation of solid waste components is accomplished to achieve the recovery and reuse of materials. Cardboard, newsprint, high quality paper, glass, metals, wood and aluminium cans etc. are manually sorted out or salvaged either for recycling or for resale.

Compaction or Mechanical Volume Reduction: After separation of reusable or disposable articles, compacters are used to compress the waste materials directly into large containers or to form bales that can be then place din large containers. Compaction increases the useful life of landfills.

Incineration or Thermal Volume Reduction: Highly combustible wastes like plastics, cardboard, paper, rubber and combustible wastes like cartons, wood scrap, floor sweepings, food wastes etc. are subjected to incineration *i.e.,* burning at very high temperatures. Incineration results in air pollution and so proper control equipment needs to be installed to avoid contamination of environment.

In order to make this method economical, the heat generated during incineration is usefully utilized by generating steam or by putting a waste heat boiler on the incinerator thereby party recovering the cost of waste collection and disposal.

Open Dumping: Open dumping of solid wastes is done in low lying areas and outskirts of the towns and cities. Being comparatively cheaper, this method of disposal is used extensively in India. However, major disadvantages are:

a. Public health hazards are caused by the breeding of flies, mosquitoes, rats and other pests.
b. Obnoxious gaseous and particulate matters are produced by burning of the combustible solid wastes, resulting in air pollution.
c. Open dumping requires large land areas which further aggravate the problem of land shortage for human habitation.
d. Fly generation

e. Encouragement of rodents
f. Static water pollution and aerial nuisance

Sanitary Landfilling or Controlled Tipping: Sanitary land filling involves the disposal of municipal wastes on or in the upper layers of the earth's mantle especially in degraded areas in need of restoration.

In landfilling, the solid wastes are compacted and spread in thin layers, each layer being uniformly covered by a layer of soil. The final layer is covered by a final cover of about one meter of earth to prevent rodents from burrowing into the refuse and scattering. This is a biological method of waste treatment and bacterial refuse digestion results in decomposition products like CO_2, CH_4, NH_3, H_2O which can be harnessed as renewable sources of energy. his method does not cause environmental damages by creating nuisances or health hazards as the refuse is covered and prevents breeding of pests and disease vectors. Besides there is no danger of air pollution resulting from burning and no water pollution provided precaution is taken to avoid leachates of refuse from contaminating the surface or underground water sources. This prevention can be taken by using a plastic membrane or watertight membrane on the base.

Pyrolysis or Destructive Distillation: In this disposal method, the solid wastes are heated under anaerobic conditions (i.e. burning without oxygen).
The organic components of the solid wastes split up into gaseous liquid and gaseous fractions (CO,CO_2, CH_4, tar, charred carbon). Unlike the highly exothermic process of combustion, pyrolysis is a highly endothermic process and that is why it is also called destructive distillation.

Landfarming: In this waste disposal method, the biodegradable industrial wastes are treated by the biological, physical and chemical processes occurring in the surface of the soil.. The organic wastes are either applied on the land or injected below the soil surface with suitable equipment, where they undergo bacterial and chemical decomposition. At frequent intervals, the landfarming sites can be reused without any adverse effects provided the land farming site is properly managed.

Composting or Biodegradation: Bacterial decomposition of the organic components of the municipal solid wastes result in formation of humus of compost and the process is known as composting. In this process a compost pile is constructed by making alternate layers of organic matter and soil (source of micro-organisms). Some fertilizer and water is periodically added to the compost pile to stimulate microbial (bacteria and fungi) action and to maintain the necessary moisture content (55%).

Periodically, the refuse is turned over to allow aeration i.e. penetration of oxygen to all parts of the organic refuse to facilitate aerobic bacterial decomposition. It takes nearly a month for composting to be complete. Large waste products such as machinery, ole furniture, abandoned vehicles etc. are required to be reduced in size in order to become capable of being handled by pulverisers. This reduction in size is usually achieved by using impact crushers or hydraulic shears.

Waste Utilization: A developing country cannot afford wastage. By proper utilization of solid waste a developing country like India can avail of many advantages, for instance,

a. Waste utilization directly or indirectly contributes to economic development.
b. Waste utilization generates employment opportunities
c. Unused solid wastes create environmental hazards by spreading diseases and causing air and water pollution.
d. Waste utilization helps in conservation of natural resources.
e. Waste utilization helps to generate many useful products which are the basic necessities of life

Resource recovery or waste utilization is achieved by three techniques:

1. Reuse *i.e.* a given material has multiple uses.
2. Reclamation *i.e.* a component of the waste is recovered for use in a manner different from its original use.
3. Recycling i.e. isolating the material from which a given product was made and reintroducing it into the production cycle for production of the same product.

Examples of waste Utilization:

a. Clean water resulting from treatment of industrial effluents and sewage can be reused.
b. Refilling of used cold drink bottles.
c. Jute wastes are utilized for making good quality paper, box-boards and hard boards.
d. Sugarcane wastes are utilized for production of electricity, paper, boards etc.
e. Waste products of slaughter houses can also be utilized. Blood is used in pharmaceutical industry and hides and skins are used for leather production.
f. Cattle dung is used in gobar gas plants for making cooking gas.
g. Cattle dung is used as manure.
h. Garbage is used for making compost.
i. Waste paper is recycled to form paper, cardboard, good quality paper and paper bags etc.
j. Scrap glass is used in production of new glass.
k. Aquatic weeds like water Hyacinth (Eichhornia) is utilized by conversion into fertilizers, biogas, animal feed, paper etc.
l. Plastic is recycled to make new packs, soft waxes, greases and adhesives etc.
m. Used tyre casings are reused in the manufacture of synthetic rubber.
n. Fly ash is used as a cement substitute to make bricks etc.

Management of municipal sewage

Municipal water is supplied to its consumers for their need of life. After being used about 75% of waste water comes out from the residential areas which contains more suspended, colloidal, dissolved solids and other impurities. Disposal of these waste water near the water sources or water body, the water get polluted and which is the main breeding source of mosquitoes and disease causing organism. Also it causes more water borne diseases. In order to avoid these problems a proper management of the municipal sewage is essential. The management of municipal sewage includes

Collection of sewage water
Treatment of sewage water
Disposal of sewage water
Municipal sewage Treatment:

Sewage treatment refers to the process adopted for removal of impurities present in the sewage water. The main objectives of waste water treatment are:

To control harmful compounds to harmless compounds
To eliminate offensive smell
To remove the solid content of the sewage
To destroy the disease producing microorganism

These sewage treatments make the waste water for safe disposal into any water bodies without affecting the natural water cycle. Municipal sewage treatment consists of the following steps.

Preliminary Treatment
Primary Treatment
Secondary treatment or Biological treatment
Tertiary treatment
Sludge digestion

Preliminary treatment:

The objectives of this treatment is to remove the floating materials like wood, paper, plastic etc., and floating matter such as oils, grease, soap etc present in sewage water.

The process of removing the large solid floating material from sewage by allowing it to pass through screens is called screening.

The process of removal of suspended floating matters such as oils, grease etc. by skimming tanks is called skimming.

Primary Treatment:

A larger portion of inorganic suspended matter cannot be removed by preliminary treatments but it is separated from the sewage by sedimentation and coagulation process. After the preliminary treatment the sewage water passed into large sedimentation tanks .In this tanks most of the solid materials sink to bottom. About 50-60% of Total suspended solids and up to 50% of pathogens and toxic contaminated are removed. The very fine suspended matters are removed by adding chemical coagulants in the sedimentation tank. The process is known as chemical precipitation or coagulation.

In this treatment, certain salts of heavy metal like Fe and Al are added to the sewage and heavy precipitates are developed, which entrap the very fine TSS and sediment on the tank. The solid settled out from these sedimentation tanks are referred as sludge. The settled sludge is incinerated, dumped in landfill or composted.

$Al_2 (SO_4)_3 + 6 H_2O \rightarrow 2 Al (OH) + 3H2SO4$

After this primary treatment the effluent quality with a BOD & TSS not exceeding 130mg/L can be obtained.

Secondary Treatment or Biological treatment:

The treatment of sewage with bacteria is called as secondary treatment. It removes the nonsettleable solid. The objective of this treatment is to remove the soluble, suspended and colloidal organic matter by active micro organisms. By using either aerobic or anaerobic bacteria the organic materials present in the waste water are broken down. Based on the nature of microorganism used the treatment method are divided into two type.

Aerobic treatment: In case of aerobic treatment, the organic matters are decomposed into water and CO_2 by aerobic bacteria

$$C_6H_{12}O_6 + 6O_2 \rightarrow 6\,CO_2 + 6H_2O$$

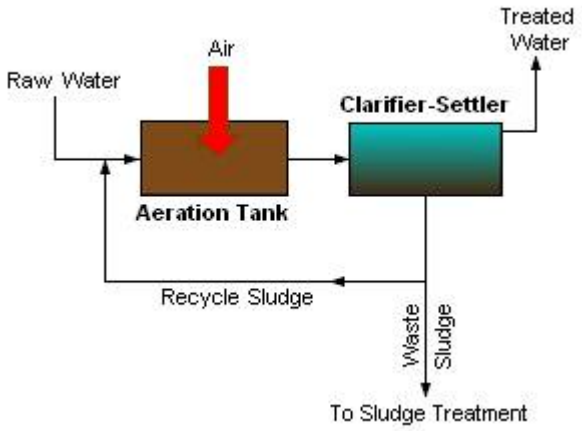
Anaerobic treatment:

In the aerobic decomposition, the organic matter are decomposed in to CH_4 and CO_2 by anaerobic bacteria

$$C_6H_{12}O_6 \rightarrow 3\,CO_2 + 3CH_4$$

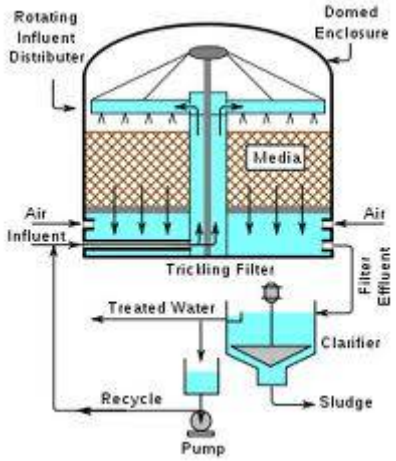
The very important aerobic treatment is Activated sludge process and Trickling filter method.

Activated sludge process: The activated sludge is biological active organic materials containing large number of aerobic bacteria which have a property to oxidize the organic matter. It is obtained by setting sewage in the presence of abundant O_2.



Trickling filter method:

It is circular tank and is filled with either coarse or crushed rock. Sewage is sprayed over this bed by means of slowly rotating arms. When sewage starts percolating downwards, microorganisms present in the sewage grow on the surface of filtering media using organic matter as food. After completion of aerobic oxidation, the treated sewage is taken to setting tank and the sludge is removed. This process removes about 80-85 % of BOD.



Tertiary treatment: After the secondary treatment, the sewage effluent has a lower BOD, Which can be removed by tertiary treatment. In the treatment, the effluent is introduced into a flocculation tank, where lime is added to remove the phosphates, from the flocculation tank effluent is led to ammonia stripping tower, where pH is maintained to 11 and ammonium ions are converted into gaseous NH_3. The effluent is allowed to pass through active charcoal Colum, where minute organic wastes are absorbed by charcoal.

Disinfection: After passing through primary, secondary and tertiary treatment the waste water is treated with sodium hypochlorite and sodium bisulphate makes it fit for discharge on the land surface. After the disinfection the effluent is ready to be discharge on land surface can be done by either spray irrigation or surface water discharge

HAZARDOUS WASTES

Hazardous waste is any discarded solid or liquid materials that is toxic ignitable, corrosive or reactive enough to explode or release toxic fumes.

(or)

Wastes that create danger to the living community, immediately or over a period of time are called as hazardous wastes.

The hazardous wastes are often found in the form of solids, sludge or gases. Safe collection, handling and disposal of these wastes are very important and great care and caution should be taken for these processes.

Eg: Chemical, biological, flammable, explosive, radioactive waste.

Characteristics:

- It can be toxic to living things when ingested or absorbed. The toxicity of hazardous waste will produce metabolic disorder, poisoning, cancer and mutation.
- It catches fire easily.
- Radioactivity-It may release ionizing radiation.
- Corrosive.
- Highly reactive.

Sources of Hazardous Wastes:

Even though many industries are producing more amount of hazardous wastes, hospitals and biological research centres are the principle sources.

1) Automobile industries, chemical industries, coal, electroplating, lather, metallurgical, petroleum, textile industries, hospital & research laboratories.

Management of Hazardous Wastes:

The following steps are involved in management of hazardous wastes.

a) Storage

b) Collection and Transportation

c) Treatment and

d) Disposal

Generation ——→ Storage ——→ Collection & Transportation ——→ Treatment ——→ Storage——→ Disposal

Storage of Hazardous Wastes:

It should be stored in tanks, metal drums and concrete vaults.

- Large quantity of hazardous wastes are generated special facilities are used with sufficient capacity to hold wastes accumulated over a period of several days.
- When only small amount of hazardous wastes are generated, they may be containerized and limited quantities may be stored for periods covering months or years.
- All the storage sites are designed in order to protect the environment and people from contamination of radiation.
- Regular monitoring is essential for storage sites.

Collection and Transportation of Hazardous Wastes:

- The sealed drums or other sealed containers which stored the hazardous wastes are loaded to the collection vehicle by either manually (or) mechanically.
- The wastes stored in tanks are either drained or pumped into the collection vehicle.

Treatment of Hazardous Wastes:

Treatment of hazardous waste has two purposes.

- To recover useful materials from the waste.
- To prepare the waste for disposal.

The treatment of hazardous waste may be broadly discussed under 3 categories.

1. Physical treatment
2. Chemical treatment
3. Biological treatment

Physical Treatment:

It is based on the principle of gravity and natural floatation.

(a) Sedimentation: tanks are used to settle the settle able sludge and can be collected at the bottom of the tank. Earlier the floating solids can be removed by a skimming device. A finally divided bubble may be introduced into the tank which rises the waste materials. The sludge, collected can be further concentrated by evaporation, filtration or by a centrifuge.

(b) Adsorption: It is adopted to remove the original material. The technique of adsorption involves the physical adhesion of the hazardous waste on to the surface of the adsorbent. Eg: Granular Activated Carbon.

(c) Aeration: The chemicals are highly volatile contaminated water is sprayed downwards in the stripper through a packaging material in a tower, while air is blown upwards carrying always the volatile organic compounds. Eg: Benzene, Toluene.

Chemical Treatment:

The waste materials are converted to less hazardous form. In addition, it produces some useful products.

(a) Corrosive waste: (at pH 2 and 12.5) can be chemically neutralized. Acidic waste are neutralized by slaked lime [$Ca(OH)_2$]. Alkaline waste neutralized by adding the acid (or) bubbling in gaseous CO_2 forming H_2CO_3 which is less hazardous.

(b) Chemical Precipitation: The heavy metal can be removed from the liquid waste by chemical precipitation which is pH dependent process. Adjusting pH around the neutral value (7) the solubility of toxic metals can be reduced leading to formation of precipitation. This is removed by settling and filtration.

(c) Chemical oxidation:

$$Cr^{6+} \xrightarrow{SO_2} Cr^{3+}$$

SO_2 -------> reducing agent.

Incineration:

In this process, the wastes are heated to over 1000 °C, for a sufficient period of time to ensure complete destruction. The resulting ash residue will be about 10-20% of the original volume of waste and has to be disposed off safely by landfills.

Bioremediation:

Bacteria activated sludge, aquatic plants, soil micro organisms etc. are employed to detonify materials and purify effluents.

Disposal of Hazardous Wastes:

Disposal is the final step in the waste management process. It is the permanent isolated of the hazardous waste. The disposal site must be for away from large population centers. These sites must have a very dry climate and extremely deep water tube.

Land filling is the most common method used in disposal of hazardous wastes.
Generally sanitary land filling methods of disposal are adopted for non-hazardous wastes.

- ✓ Radioactive substances are to be handles with more care because they contaminate air, water and land dangerously deteriorate the life supporting system of living organisms and retain long periods of time.
- ✓ Radioactive wastes with low level of radiation should be treated for removal of its radioactivity and discharged into any water bodies or an land in usual manner.

High levels of radioactive wastes are to be concentrated, packed in disposal containers and finally disposed out of the reach of living environment.

Biomedical waste

Biomedical wastes are defined as any solid, semi solid or liquid waste including its containers and any intermediate product which are generate red during diagnosis, treatment or immunization of human being/animals or in production and testing of biological parts.

Types on Biomedical waste

- Needles
- Scalpel blades
- Syringes
- Contaminated gloves
- Dishes used for microbiological
- Human anatomical waste
- Blood soaked items such as gauze pads and other absorbents
- Wastes generated in the health centre that are known to have been in contact with an infectious agent

Sources of Biomedical waste

Hospitals, nursing homes, blood banks, clinics, medical laboratories, animal houses, etc.,

Management of Biomedical waster

Segregation at Source ——→ Storage ——→Labelling & Transportation——→Treatment—→ Disposal

Segregation at Source:

Segregation at source is done in order to avoid mixing of infectious wastes with non-infectious wastes. The generator is responsible for providing segregated waste to the operator. Segregation of waste at the source is essential for safe and hygienic waste management.

Storage:
A different colour code for waste containers is adopted for storing different types of wastes. According to the rules, the infectious waste cannot be stored for more than 48 hours. However, hospital waste may need to be stored, if immediate treatment and disposal cannot be done.
These wastes should be refrigerated on site to prevent rotting and offensive smells. These wastes may be stored in storage houses away from the general public.

Labelling:
It is essential to affix or otherwise imprint a waste resistant label on the outside of each container indicating contents of the container before the transportation process.

Transportation: Specially designed vehicles are used in transporting untreated biomedical wastes. Every time a vehicle is unloaded, the vehicle and empty containers shall be washed properly and disinfected**.**
Treatment:

a) **Incineration:** waste is heated in the presence of air at high temperature. The waste is completely oxidized and harmful micro-organisms present in it are destroyed under high temperature.
b) **Auto claving:** Autoclaving is a low-heat thermal process. It is designed to bring steam into direct contact with the wastes, in a controlled manner and for sufficient duration to disinfect the waste.
c) **Microwaving:** Microwaving is an inter-molecular heating process with electromagnetic radiation of frequency between 300 and 300, 000MHz. the heating occurs inside the waste material in the presence of steam. Microwave

treatment shall not be used for cytotoxic, hazardous or radioactive wastes, contaminated animal carcasses, body parts and large metal items.

d) Hydroclaving: Hydroclaving is similar to that autoclaving. The only difference is that the waste is subjected to indirect heating by applying steam in the outer jacket. The waste is continuously tumbled in the chamber during the process.

e) Chemical Disinfection: chemical Disinfection is done using at least 1% hypochlorite solution or any other equivalent chemical reagent. This type of treatment is an option for the treatment certain categories of biomedical waste.

f) Shredding: Shredding is a process by which the wastes are reshaped or cut into smaller pieces so as to make the wastes unrecognizable. It helps in prevention of reuse of biomedical waste.

Disposal: Biomedical waste should be disposed of frequently to reduce accumulation of these materials in

works areas.

Deep burial shall be an option available only in towns with population less than five lakhs and in rural areas.

Lanfill: the waste is covered by thick layer of soil.

Mutilation/Shredding must be such so as to prevent unauthorized reuse.

The following table shows the classification, colour coding, treatment and disposal of biomedical wastes.

Category	Waste type	Colour coding	Treatment and Disposal Method
1	Human Anatomical wastes	Yellow	Incineration/Deep Burial
2	Animal Wastes	Yellow	Incineration/Deep Burial
3	Microbiological and Biotechnology wastes	Yellow/Red	Local Autoclaving/ Microwaving/Incineration
4	Waste sharps	Blue/White	Disinfection/ Autoclaving/ Microwaving/ Incineration
5	Discarded medicines and cytotoxic drugs	Black	Incineration/Secure landfill
6	Solid Wastes	Yellow	Incineration/ Autoclaving/ Microwaving
7	Disposable Solid wastes like tubes, catheters, blood or urine bags, gloves, etc	Red/Blue	Disinfection, Multilation/Shredding
8	Liquid Wastes	Blue/Red	Disinfection and Discharge into sewers
9	Incinerated ash	Black	Landfills
10	Chemical solid wastes	Black	Disinfection and Discharge into sewers for liquids and secured landfills for solids

WASTE MINIMIZATION TECHNIQUE

"Prevention and/or reducing the generation of waste, improving the quality of waste generated by reduction of hazard, and encouraging re-use, recycling and recovery".
Waste minimization is aimed at reducing the generation of waste through education and improved production process rather than attempting to enhance technology to improve treatment of waste.

Minimizing waste generation has the potential

→to reduce cost

→to reducing the amount of waste to be disposed and hence the cost of waste management.

→to increase the profits by maximizing the use of resources.

Waste can be minimized by any one of the following approaches/techniques

- Waste prevention/waste reduction at source.
- Reuse
- Materials & recycling
- Recovery.

Source Reduction:

Source reduction is generally considered to be the waste minimizing techniques with greatest potential for avoiding energy and material consumption as well as waste production.

- With respect to the hazardous industrial waste, source reduction not only reduces the volume or weight of the waste but also reduces the toxicity.

Many different approaches have been identified to reduce the industrial waste at source. The source reduction may be considered mainly of four types.

a) Product changes
b) Technology changes
c) Source control
d) Good house keeping

Product Changes:

- It refers to a change in the nature of the product so that it will produce less waste or release fewer contaminates into the environment.
- It does not refer to a direct reduction of size of a products packaging.

(eg by substituting plastic packaging with paper packaging, but can denote a change in the product that will ultimately require less packaging.)

Source Control:

These are the measures that reduce the waste & toxicity associated with a products manufacture.

Input material changes are the source control measures which includes

- The purification of raw material inputs.
- Substitution of less toxic materials.
- Improve material receiving, storage, and handling practices.

Technology Changes:

Waste generation at source is reduced by technology changes. It includes,

- ✓ Changes in the design of production process.
- ✓ Purchase of new efficient equipments.
- ✓ Changes in the operating condition and changes in process control.
- ✓ Improving chemical syntheses.
  (for eg. By using a more selective catalyst to reduce by-product formation.)

Reuse & Recycling:

Waste materials generated during the production process can be reused or recycled either on site or off site.

Reuse involves reuse of a material in its original form, possible after cleaning but not including waste separation and material reprocessing.

The reuse of materials is important for the conservation & recovery of resources. It saves energy in the production process.

- It reduces emission to air & water.
- It reduces disposal impact.

Recycling:

Collection and separation of materials from waste and subsequent processing to produce marketable products. The waste recycling involves processing of materials from waste streams, which are broken down into raw materials and reprocessed into the same materials or a new product. Waste materials that are recycles requires some form of significant physical, chemical or biological processing. For example: The used paper must be pulped and remanufactured before it can be used again. If the value of raw materials input tends to be higher for their availability is low, recycled or reused materials more attractive.

Waste Recovery:

Waste recovery (or) secondary resource recovery is the range of activities characterized by the treatment and use of materials (or) energy from waste through thermal, chemical (or) biological means.

There are two main groups of SRR processes biological processes such as

- Composting, anaerobic digestion
- Vermiculture.

Thermal and chemical processes-Incineration
SRR fulfill the social, environmental and economic goals.

Benefits of Waste Minimization:

- ✓ Decreased long-term liabilities for cleanup of waste materials.
- ✓ Improved product quality.
- ✓ Decreased worker health risks.
- ✓ Improved public image of the company.
- ✓ Environmental improvement.
- ✓ Financial return.
- ✓ Improved customer satisfaction.

Clean Technology or Cleaner production or Cleaner Technology

Definition: Any technology which uses less energy, fewer raw materials, generates minimum waste than the existing technology or process.

Implementation of clean-technology in Industry

- Creating awareness of environmental issues.
- Establishing environmental policy.
-

Application of clean technology

- Volume reduction
- Waste minimization
- Waste recycling
- Reuse and by product recovery in various industries.

Advantages of Clean Technology

1) Helps to use fewer raw materials, energy and less waste.
2) Helps to reduce treatment and disposal costs.
3) Reduces risk of fines from pollution control boards.
4) Helps to ensure safety of workers.
5) Increased public satisfaction

Examples: Fuel cell, biodiesel, Bio-fertilizer, Environmental degraded plastic.

Green Chemistry

Introduction:

Green chemistry is a highly effective approach to pollution prevention because it applies innovative scientific solutions to real-world environmental situations. **Green chemistry**, also called sustainable chemistry, is a philosophy of chemical research and engineering that encourages the design of products and processes that minimize the use and generation of hazardous substances. Green chemistry consists of environmentally friendly, sustainable chemicals and processes whose use results in reduced waste, safer outputs, and reduced or eliminated pollution and environmental damage. Green chemistry encourages innovation and promotes the creation of products that are both environmentally and economically sustainable.

Principles of Green Chemistry

The 12 Principles of Green Chemistry, originally published by Paul Anastas and John Warner in **Green Chemistry: Theory and Practice** (Oxford University Press: New York, 1998), provide a road map for chemists to implement green chemistry.

The principles cover such concepts as:

- the design of processes to maximize the amount of raw material that ends up in the product;
- the use of safe, environment-benign substances, including solvents, whenever possible;
- the design of energy efficient processes;
- the best form of waste disposal: not to create it in the first place.

Principles

1. **Prevention**

   It is better to prevent waste than to treat or clean up waste after it has been created.

2. **Atom Economy**

   Synthetic methods should be designed to maximize the incorporation of all materials used in the process into the final product.

3. **Less Hazardous Chemical Syntheses**

   Wherever practicable, synthetic methods should be designed to use and generate substances that possess little or no toxicity to human health and the environment.

4. **Designing Safer Chemicals**

   Chemical products should be designed to effect their desired function while minimizing their toxicity.

5. **Safer Solvents and Auxiliaries**

   The use of auxiliary substances (e.g., solvents, separation agents, etc.) should be made unnecessary wherever possible and innocuous when used.

6. **Design for Energy Efficiency**

   Energy requirements of chemical processes should be recognized for their environmental and economic impacts and should be minimized. If possible, synthetic methods should be conducted at ambient temperature and pressure.

7. **Use of Renewable Feedstocks**

   A raw material or feedstock should be renewable rather than depleting whenever technically and economically practicable.

8. **Reduce Derivatives**

   Unnecessary derivatization (use of blocking groups, protection/ deprotection, temporary modification of physical/chemical processes) should be minimized or avoided if possible, because such steps require additional reagents and can generate waste.

9. **Catalysis**

   Catalytic reagents (as selective as possible) are superior to stoichiometric reagents.

10. **Design for Degradation**

Chemical products should be designed so that at the end of their function they break down into innocuous degradation products and do not persist in the environment.

11. **Real-time analysis for Pollution Prevention**

Analytical methodologies need to be further developed to allow for real-time, in-process monitoring and control prior to the formation of hazardous substances.

12. Inherently Safer Chemistry for Accident Prevention

Substances and the form of a substance used in a chemical process should be chosen to minimize the potential for chemical accidents, including releases, explosions, and fires.

Benefits:

Green chemistry technologies provide a number of benefits, including:

- reduced waste, eliminating costly end-of-the-pipe treatments
- safer products
- reduced use of energy and resources
- Improved competitiveness of chemical manufacturers and their customers.

Role of green chemistry in controlling environmental pollution

The major uses of Green Chemistry

- Energy
- Global Change
- Resource Depletion
- Food Supply
- Toxics in the Environment

Energy

- The vast majority of the energy generated in the world today is from non-renewable sources that damage the environment.
  - Carbon dioxide
  - Depletion of Ozone layer

- Effects of mining, drilling, etc
- Toxics

- Green Chemistry will be essential in
  - developing the alternatives for energy generation (photovoltaics, hydrogen, fuel cells, biobased fuels, etc.) as well as
  - Continue the path toward energy efficiency with catalysis and product design at the forefront.

Global Change

- Concerns for climate change, oceanic temperature, stratospheric chemistry and global distillation can be addressed through the development and implementation of green chemistry technologies.

Resource Depletion

- Due to the over utilization of non-renewable resources, natural resources are being depleted at an unsustainable rate.
- Fossil fuels are a central issue.
- Renewable resources can be made increasingly viable technologically and economically through green chemistry.
  - Biomass
  - Nanoscience & technology
  - Solar
  - Carbon dioxide
  - Chitin
  - Waste utilization

Food Supply

- While current food levels are sufficient, distribution is inadequate
- Agricultural methods are unsustainable
- Future food production intensity is needed.
- Green chemistry can address many food supply issues
- Green chemistry is developing:
  - Pesticides which only affect target organisms and degrade to innocuous by-products.

- Fertilizers and fertilizer adjuvants that are designed to minimize usage while maximizing effectiveness.
- Methods of using agricultural wastes for beneficial and profitable uses.

Toxics in the Environment

- Substances that are toxic to humans, the biosphere and all that sustains it, are currently still being released at a cost of life, health and sustainability.
- One of green chemistry's greatest strengths is the ability to design for reduced hazard.

DISASTER MANAGEMENT

Disaster is a situation arising from natural forces where large scale disruption of infrastructure, services etc., causing a serious effect on human life, economy and environment. There are various types of disaster which cause devastation. Earth quakes, snow fall, lighting, floods, cyclones, rain fall, drought, volcanic eruption, land slides and forest fire are some of the natural disasters that kill thousands of people and destroy corers of rupees or dollars of habitat every year. These natural disasters are classified into two types based on the origin.

Geographical Origin: Earth quakes, volcanic eruptions and landslides.

Climatic origin: Drought, flood, cyclone and forest fire.

Earthquakes

Earthquakes occur due to sudden movements of earths curst. The earths curst have several tectonic plates of solid rock which is slowly move along their boundaries. When friction prevents there plates from slipping, stress builds up and results in sudden fractures which can occur along the boundaries of the plants or fault lines (planes of weakness) within the plates. This causes earthquakes which leads to the violent short-term vibration in the earth. The point on a fault line at which the first movement occurs during the earthquake is called the "epicentre".

The effect of earthquake is measured by using Richter scale.

Richter Scale	Severity of earthquake
Less than 4	Insignificant

4 – 4.9	Minor
5 – 5.9	Damaging
6 – 6.9	Destructive
7 – 7.9	Major
More than 8	Great

The largest earthquake occurred on May 22, 1960. in "Chile". Its magnitude is 9.5 Richter scale, affecting 90,000 square miles and killing 6,000 people. The earthquake in Gujarat had caused massive damage, killed 20,000 – 30,000 people and many people injured.

The magnitude of Earth quake is greater than the 8.5 in Richter scale having ability to generate water waves called tsunamis can severely affect coastal areas. These giant sea swells can move at a speed up to 1000km/hr or even faster. While approaching the sea shore they may often reach 15m or up to 65m in height and cause massive devastation in coastal areas. In china such waves killed 8, 30,000 people in 1556 and 50,000 in 1976.

Anthropogenic activities can also cause or enhance the frequency of earthquakes. They are:

b. Storage of huge amount of water in the lake behind a big dam.
c. Underground nuclear testing
d. Deep well disposal of liquid waste

Damage to property and life can be prevented by constructing earthquake – resistant buildings in the earthquake prone zones or seismic areas. For this, the structures are heavily reinforced, spots are strategically placed in the building that can absorb vibrations from the rest of the building, pads or floats are placed beneath the building on which it can shift harmlessly during ground motion. Wooden houses are preferred in earth quake prone areas as Japan.

Floods

Flood is the over of water which exceeds the carrying capacity of the Receiving River and stream system. It occurs due to heavy rain fall, melting of ice or snow and heavy tides. During the flood, the river carries fertile sediments and deposits it on the level land along its course. Such areas are called flood plains which are very fertile. Some rivers with extensive flood plains are the Nile, Ganga, Bramaputra, Yellow river, Godavari etc. Often the flood plains become areas for human settlement. People are lured to them by the productive soil, reliable water supply, inexpensive means of transport and fishing potential.

Consequences of flood:

- Vegetation is removed due to rapid water flow over the surface into streams.
- Increases the soil erosion
- Carries fertile sediment towards the lower areas.
- Loss of materials and life.
- Reduces the capacity of rivers or streams by filling various sediments.

Control measures:

- Proper watershed managements, control soil erosion and reduce surface run off.
- Build more dams to store the flood water coming from the properly managed watersheds.
- Design cities and town to retain more water and release it more slowly following rain fail.

Landslides

Landslides occur when coherent of soil masses move down slope due to gravitational pull. Slow landslips don't cause much effect but sudden rock slides and mudslides are dangerous.

Water and vegetation influence landslides. Chemical action of water gradually cause chemical weathering of rocks making them prove to landslides. Vegetation consolidates the slope material, provides cohesion by its root system and also retards the flow of water and its erosion capacity.

However, this can be occurred by other factors like:

1. Earthquakes, vibration etc.,

2. Disturbances in resistant rock overlying rock of low resistance
3. Saturation of the unconsolidated sediments with water.
4. Unconsolidated sediments exposed due to logging, road or house building.

Landslides are governed by the forces which tend to pull the earth material down slope and resisting forces which tend to resist such movements. It is difficult to control landslides. However, these can be minimized by stabilizing the slope by

1. Draining the surface and subsurface water
2. Providing slope support like gabions
3. Concrete support at the base of a slope.

Cyclone

Cyclone is recurring phenomena in the tropical coastal region. Among the natural disasters, cyclones claim higher death rates and destruction throughout the world. Cyclones, hurricanes and typhoon's, although named differently which describe the same disaster type. Essentially, these disaster types refers to a large scale closed circulation system in the atmosphere which combines low pressure and strong wind that rotate counter clockwise in the northern hemisphere. These disasters can be predicted several days in advance, so it is called as warning calamities.

First, high winds cause major damage to infrastructure and housing in particular fragile constructions. Then followed by heavy rains, flood and material losses are therefore often very high.

Although there are many locations in Asia that have enjoyed the benefits of development and economic growth over recent years, there are other areas that face difficult problems as a consequence of their unique geographical locations. Asia is a vast continent with many remote and inaccessible regions. The continent is also faced with a range of potentially severe natural hazards. Asia supports a huge population and many people have very limited resources. Living condition can be harsh for people who have to contend with a debilitating climate and limited infrastructure. Many people regularly face the consequences of disasters, the outcome of which bring ill health to the vulnerable and constrain the pace of potential development. Since India has large coastal area, it is greatly affected by cyclones which develop due to the formation of low pressure zone in

the sea. Cyclones having their disastrous effects in the sea coasts between April and May and between October and December.

Tsunami

Tsunami is a Japanese word which means “harbour wave.” “Tsu” means harbour and “name” means wave.

Definition

A tsunami is large waves that are generated in a water body when the sea floor is deformed by seismic activity. This activity displaces the overlying water in the ocean.

Causes of tsunami

1. Seismic activities like earthquakes, landslides, volcanic eruptions, explosions can generate tsunami.
2. Deformation of the sea floor due to the movement of plates.

Effects of tsunami

1. Tsunami attacks mostly the coast lines, causing devastating property, damage and loss of life.
2. Tsunami can kill lot of human beings, live stocks.
3. Tsunami may also spread lot of water borne diseases.

Tsunami management

Tsunami management is carried out by the following steps

1. Earthquakes, under the water, are monitored by sensors on the floor of the sea.
2. The sensors send the information of floating buoys on the surface, whenever they detect any changes in pressure of the sea.
3. The information is then relayed to satellites, which passes it on to the earth stations.
4. All member nations of the warning system are then warned of the danger approaching.

5. Finally the country make the people alert through the media to take all necessary precautions.

UNIT V

SOCIAL ISSUES AND THE ENVIRONMENT

WATER CONSERVATION:

Leonardo da Vinci said, "Water is the driver of life on the earth" The original source of water is precipitation from the atmosphere. The water is available on the earth in all three states as gas, liquid and solid. About 75 % of the earth's surface is covered by the hydrosphere. About 97 % of water available on the earth is salt water, 2 % of water is locked up in the polar region as ice and the remaining 1 % of water is available as ground water. With increase in population and erratic agricultural activities, the quality and quantity of water have declined. So, the conservation of water is most important. It is done by following ways.

1. **Decreasing run-off losses:** Huge water loss occurs due to run off on the soils, which can be reduced by allowing water to infiltrate into the soil. This can be achieved by using contour cultivation water spreading, chemical treatment or improved water storage system.

2. **Reducing irrigation losses:**
    - Use of lined or covered canals to reduce seepage
    - Irrigation is early morning or late evening to reduce evaporation losses.
    - Sprinkling irrigation and drip irrigation to conserve water by 30 – 50%.
    - Growing hybrid crop varieties with less water requirements and tolerance to saline water help to conserve water.
3. **Reuse of water**
    - Treated wastewater can be used for ferti-irrigation
    - Using grey water from washings, bath tubs etc., for watering gardens, washing cars or paths help in saving fresh water.
4. **Preventing wastage of water:** This can be done in house holds, commercial buildings and public places.

- Closing taps when not in use
- Repairing any leakage from pipes
- Using small capacity flush in toilets

Development of large scale underground water reservoirs Economical use of water resources should be encouraged. Discharge of sewage into natural water resources should be prevented as much as possible. Preserve the natural water by methods like rain water harvesting, building dams, saving in ponds, lakes etc.

Rain water harvesting: The process of collection of rain water directly or recharging it into the ground water storage in the aquifer is called rain water harvesting.

Objectives of rain water harvesting:

1. To reduce run off loss
2. To avoid flooding of roads
3. To meet the increasing demands of water
4. To raise the water table by recharging ground water
5. To reduce ground water contamination
6. To supplement ground water supplies during lean reason.

Necessity: During the rainy season, the storm water runs over the fields and lands and finally it reaches the sea. This kind of storms water flow causes soil erosion. Hence an essential steps toward directing the rain water into the ground results more benefits to the people as well as the environment. This kind of action increases the ground water table level and decreases the water problem during the summer season.

Components of rainwater harvesting system:

A rain water harvesting system has the following components as shown in fig.

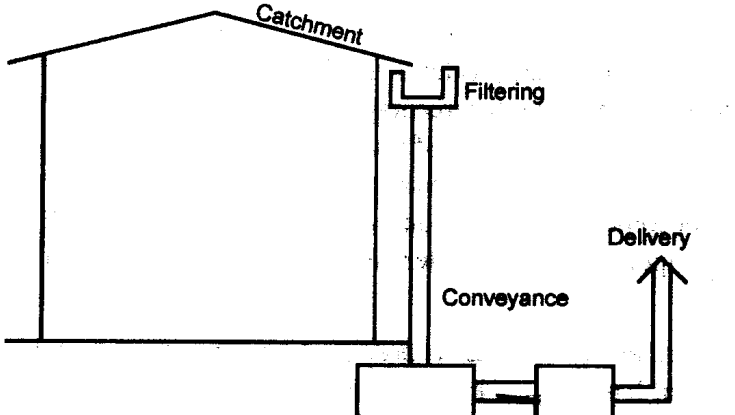


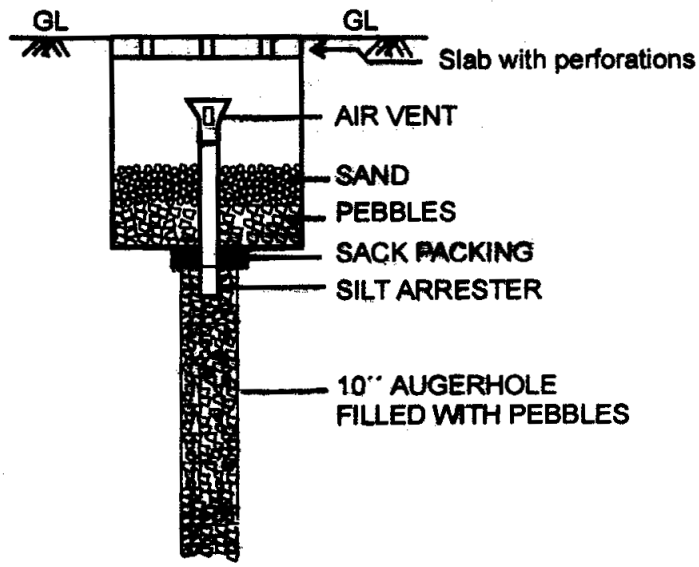
Fig. Components of rain water harvesting system

1. **Catchment:** The surface upon which the rain falls
2. **Filtering:** The system that filter and remove contaminants and debris.
3. **Conveyance**: Transport channels or pipes from catchment area to storage tank.
4. **Storage** : Tanks where the collected rain water is stored
5. **Purification**: It includes filtering equipment, distillation and additives to settle help to filter and disinfect the collected rainwater.
6. **Distribution**: The system that delivers the rain water.

Rainwater can be mainly harvested by any one of the following methods.

1. Absorption pit method
2. Absorption well method
3. Well cum bore method.

Absorption pit method:



In this method a hand bore made in the soil is used to harvest the rain water. This type of harvesting structure is suitable for gravely soil. The percolation or absorption pit is made

to a size of about 10 inches in diameter and 4 to 8 meters length. It is filled with pebbles or broken bricks at bottom and river sand on top. A square or circular collection chamber is constructed with slit arrester is provided at the top to collect and feed the pit. At the ground level a perforated slab is used to cover the pit.

Percolation well cum bore pit method: This type of structure where the soil is likely to be clayey upto 5 m and more. A percolation well upto 3 to 5 m depth and then a hand pore upto a depth of 3 to 5m height within the well is suitable for this type of structures. Usually the hand bore to a depth upto the reach of sandy bed is done. Then a pipe of 150 mm diameter is inserted into the bore for the entire length of the bore. The well is filled with pebbles and sand and the pipe is filled with pebb]

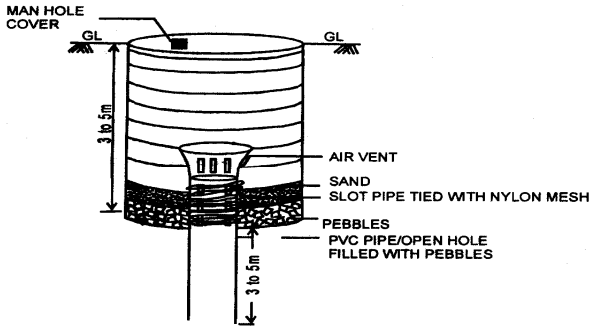


Fig. Percolation well cum bore pit method

Percolation well method: These wells are constructed to a diameter of 0.60 to 2 m. These are constructed with cement rings. Its size is depending on the type of soil strata and the number of collection pipe lines. In these types of wells no filtering medium is filled inside and the top portion is covered with RCC slab of suitable thickness.

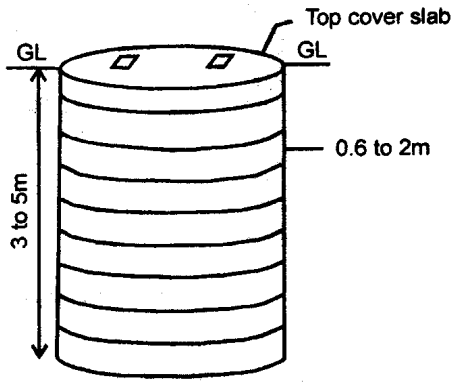


Fig. Percolation well method

Advantages of rain water harvesting

1. Rise in ground water levels
2. Increase availability of water from wells
3. Reduction in flood hazards and soil erosion
4. Mitigating the effects of droughts and achieving drought proofing
5. Reduction in the use of energy for pumping water and consequently the cost.
6. Future generation is assured of water
7. Up grading the social and environmental status.

Disadvantages:

1. The water supply is very limited
2. Uncertainty of rain fall does not effectively use this system throughout the year.

RESETTLEMENT AND REHABILITATION OF PEOPLE:

Resettlement is defined as the process of simple relocation or displacement of human population without considering their individual, community or societal needs.

Rehabilitation Is defined as the process of replacing the lost economic assets, rebuilding the community systems that have been weakened by displacement, attending to the psychological trauma of forced separation from livelihood.

The overall objective of resettlement and rehabilitation is to ensure that the affected production base will be restored, the affected labour force will be reemployed and income and livelihood of affected people will be improved or at least restored to their previous levels before resettlement.

The target of resettlement and rehabilitation is as follows:

1. The resettler's grain production level will be sufficient after resettlement.
2. The income per capita shall be recovered to the standard before resettlement.
3. The affected public infrastructures, school, hospitals, social welfare level, national environment and traffic condition shall be improved after settlement.

Effect of resettlement and rehabilitation:

The phenomenon of population displacement or involuntary resettlement of people occurs due to some serious social impact/consequences of large dams. Some people are

negatively affected by the project like construction of reservoir, infrastructure, transmission lines, roads, colony etc. These people are forced to displace from their original location to go elsewhere.

Rehabilitation is a complex problem and it cannot be satisfactorily achieved by more economic compensation. For example: In a big irrigation project, there are enormous developmental opportunities for people. At the same time, some people are affected by loosing their traditional habitats and lands due to submergence by water.

Displacement due to dam: When a massive dam is planned across a big river several problems are to be addressed.

Common Problems:

1. Submergence of valuable forest cover
2. Water logging and its adverse effects
3. Extinction of wild life and plant species
4. Possibility of an earth quake
5. The displacement of people due to submergence of their habitats and organizing resettlement and rehabilitation plans for them:

Example: Bhakra Nangal dam, Tehri dam, Hirakund dam.

Displacement due to mining: Mining is another developmental activity, which causes displacemental activity of the native people. Several thousands of hectares of land area are covered in mining operation and the native people are displaced. Sometimes displacement of local people is due to accidents occurring in mined areas like subsidence of land that often leads to shifting of people.

Displacement due to creation of National parks: when some forest area is covered under a National park, it is a welcome step for conservation of the Natural resources. So a major portion of the forest is prohibited area for local dwellers or tribal. These villagers loss rights to access the forest. So they are starting destructive activities. These are a need to book into their problems and provide them some employment.

The major issues related to displacement and rehabilitation are as follows:

1. Tribal are most affected among the displaced who are already poor. Displacement further increases their poverty due to loss of land, home, jobs, food insecurity, loss of access to common property assets and social isolation.
2. Break up of families is an important social issue arises due to displacement among which the women are the worst affected and they are not even given cash/land compensation.
3. The tribal are not familiar with the market policies and trends. Even if they get cash compensation, they get alienated in the modern economic set-up.
4. The land acquisition laws ignore the communal ownership property, which is an inbuilt system amongst the tribal. Thus the tribal lose their communitarian basis of economic and cultural existence. They feel like fish out of water.
5. Kinship systems, marriages, social and cultural functions, their folk-songs, dances and activities vanish with their displacement. When they are resettled, it is individual-based settlement, which totally ignores communal settlement.
6. Loss of identity and loss of the intimate link between the people and the environment is one of the biggest losses.

Rehabilitation policy: A sound national policy on rehabilitation and resettlement of affected people is essential.

1. The extent of damage and suffering that the proposed project would cause and the number of families/people involved should be studied and ascertained before starting the project.
2. The rehabilitation and resettlement work should be a part of the project and all those affected should be rehabilitated before the commencement of the project.
3. The people should be rehabilitated on “minimum dislocation basis” by choosing adjacent areas.
4. The extent of rehabilitation should meet the ends of social justice and balanced development.
5. The advantages of rehabilitation should be on par those of the beneficiaries of the proposed project.

WASTELAND RECLAMATION (DEVELOPMENT)

The lands which are unfit for cultivation, grazing and other economic uses due to environmental pollution is called wastelands. The wastelands are formed by natural process and man made activities. The wastelands are salt affected lands, sandy areas, gullied areas, dry hill ridge, snow covered lands, coastal saline areas, sandy area etc. The major anthropogenic activities leading to waste land formation are deforestation, overgrazing, mining and improper agricultural practices.

Wasteland Reclamation Practices:

Objectives:

1. To improve the physical structure and quality of the marginal soils.
2. To improve the availability of good quality water for irrigating these lands.
3. To prevent soil erosion, flooding and land slides.
4. To conserve the biological resources of the land for sustainable use.

Some important reclamation practices

1. **Drainage and lowering of the water table:** The source of water is causing water logging the following treatment where done. If the water logging is caused by surface water, suitable surface drainage system should be adopted. If it is caused by underground water, the source should be cut off by constructing intercepting drains.
2. **Leaching:** Before starting this process, the water table is reduced to a safe limits. In this process, the land is flooded with water to a depth of 15 to 25 cm over the surface. The excess alkalis (NaCl, Na_2SO_4 and Na_2CO_3) are dissolved in water which percolate through soil and join the water table or drained away by sub-surface drains. This process is repeated till the salts in the surface layer reduced to a safe limit.
3. **Reclamation by using chemicals:** Sodium carbonate in the soil is easily removed by spreading gypsum on the land at the rate of 20kg per hectare before leaching. Some times dilute H_2SO_4 is applied to the land to neutralize the alkalies present in the soil. Acid-forming fertilizers are also effective.
4. **By adopting rice cultivation:** Salinity of the land is reduced by adopting rice cultivation. Large amount of water is used in rice cultivation reduces the salt content in the soil by leaching action. The roots of the rice plants produce CO_2

which lowers the P^H values of soil. This rice cultivation effects a reduction in the alkalinity of the soil.

ENVIRONMENTAL IMPACT ASSESSMENT

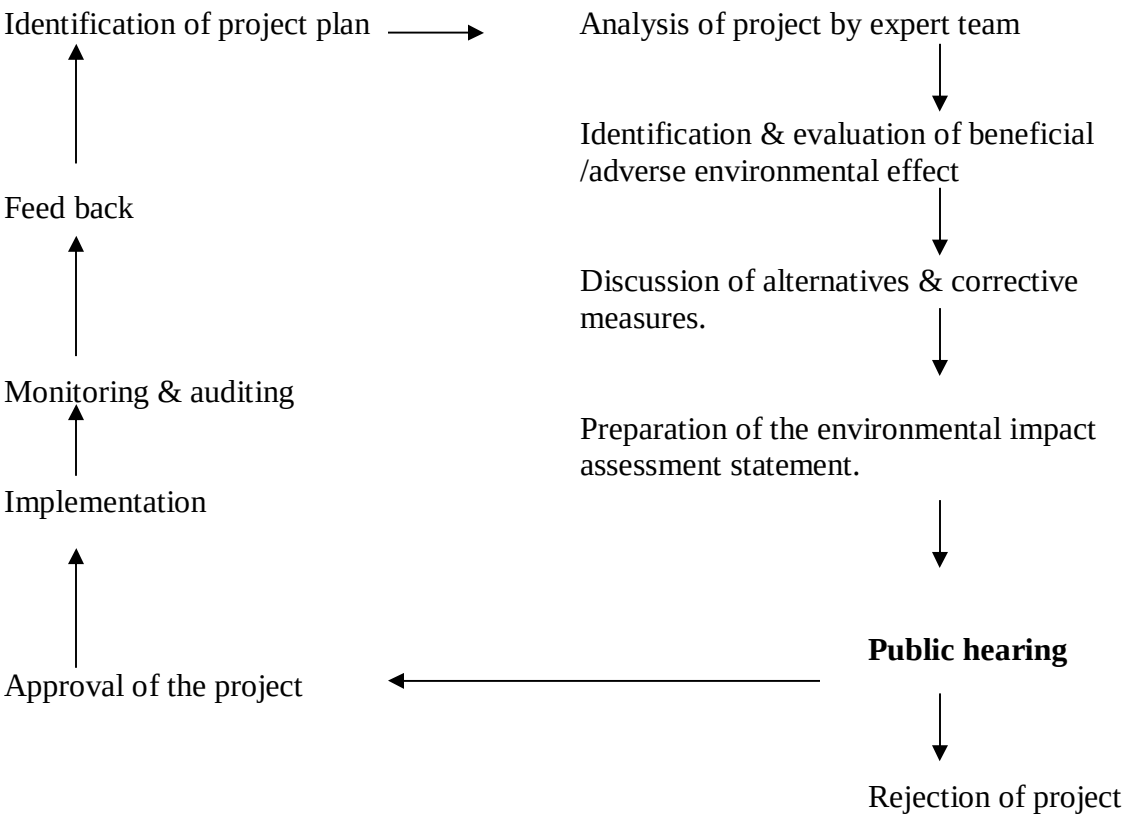
Definition:

A planning tool which identifies predicts and accesses the consequences of proposed project.

Goals of EIA:

- Resource conservation
- Waste minimization
- Recovery of by-products.
- Efficient equipment.

EIA process:



There are four phases in the EIA process.

Phase I: Organizing the job.

Phase II: Performing the assessment.

Phase III: Preparing EIA.

Phase IV: Review of EIA.

Phase I:

- The project is identified and an expert te4am is set to conduct analysis.
- Analysis includes the rules, regulations & limitations on the part of the government.

Phase II:

This phase constitutes the following.

- Site visit- to record the environmental impact before & after proposed action.
- Identification & evaluation of beneficial and adverse environmental effects.
- Discussion of alternatives.
- Preparation of a check list to EIA ensuring all the assessments made.

Phase III:

EIS is prepared by the expert team consists of the following.

- Description of the environment where the project to be take place.
- Project goal, objective, action, manpower, equipments, material requirement…
- Environmental impacts.
- Unavoidable adverse effects resulting by the activity.
- Alternative measures that can be take to minimize the adverse effects.

Phase IV:

EIS is presented to the public hearing; a period of one month is given for public hearing. After that the final decision is taken to either approve or reject the project.

If approved then the project is implemented, then it was continuously monitored and audited.

Benefits of EIA:

Cost and time saving in project implementation due to avoidance of mid course design changes or corrections.

- Increase acceptability of the project among all stakeholders
- Laws and regulations of the country is fully camplied
- Improves project performance by decreased pollutant emissions
- A healthy environment
- Improved human health
- Paves way for sustainable development.

PRECAUTIONARY PRINCIPLE

The Precautionary Principle emphasizes that when human health or the environments are threatened, precautionary measures should be taken even if cause and effect relationships are not fully established scientifically.

There are four basic components of precautionary action;

- People have a duty to take anticipatory steps to prevent harm. If there is a reasonable suspicion that something bad might happen, then there is an obligation to try to stop it.
- Before using a new technology, process, chemical or new activity people have an obligation to examine a full range of alternatives, including the alternatives, including the alternative of not using it.
- The burden of proof of carelessness of a new technology, process, activity, or chemical, lies with the proponents, not with the general public.
- Decisions applying the precautionary principle must be open, informed and democratic and must include the affected parties.

Reasons for adopting precautionary principles:

Loss of bio diversity
Destruction of eco-system
Depletion of ozone layer
Global warming
Climatic changes are all increasing. So we should adopt precautionary principle

Methods of implementing the precautionary principle:

Environmental loss and regulations can be reformed
New products and new technologies should not be allowed to operate automatically

Benefits of precautionary principles:

Encourages better, safer and cheaper alternatives
Society and future generations receive more benefits with reduced sufferings

POLLUTER'S PAY PRINCIPLE (PPP)

In environmental law**, the polluter pays principle is enacted to make the party responsible for producing pollution and they have to pay the amount to the government which is equal to the damage done to the natural environment.** Polluter pays is also known as extended polluter responsibility.

This principle implies that the who pollutes the environment and destroy its biodiversity should pay the costs of the loss of biodiversity.
According to this principle the polluters must pay for,

- The cost of pollution abatement
- The cost of environment repair
- The compensation costs for victims of environmental damages

Implementation strategies:

The polluters can be made in several ways

- Emission charge system
- Product taxes
- Deposit/refund system-to ensure the return of products containing toxic material
- Manufacturers, distributors and retailers take direct responsibility for disposal of product containing toxic materials.
- Government subsidy program
- Insurance and security.

Problems in implementing PPP:

- Identifying polluters
- Political acceptability
- Trade and competitiveness issue

Benefits of PPP:

- Greener environments
- Economics efficiency
- Incentives to reduce pollution.

THE ENVIRONMENT (PROTECTION) ACT, 1986.

The Act came into force on Nov.19, 1986 the birth anniversary of our Late Prime Minister India Gandhi, who was a pioneer of environmental protection issues in our

country. The Act extends to whole of India. Some terms related to environment have been described as follows in the Act.

1. Environment includes water, air and land and the inter-relationships that exist among and between them and human beings, all other living organisms and property.
2. Environmental pollution means the presence of any solid, liquid or gaseous substance present in such concentration, as may be, or tend to be, injurious to environment.
3. Hazardous Substance means any substance or preparation, which by its physico-chemical properties or handling is liable to cause harm to human beings, other living organisms, property or environment.
4. The Act has given powers to the Central Government to take measures to protect and improve environment while the state governments coordinate the actions.

The most important functions of Central Govt. under this Act include setting up of.

a) The standards of quality of air, water or soil for various areas and purpose.
b) The maximum permissible limits of concentration of various environmental pollutants (including noise) for different areas.
c) The procedures and safeguards for the handling of hazardous substances.
d) The prohibition and restrictions on the handling of hazardous substances in different areas.
e) The prohibition and restriction on the location of industries and to carry on process and operations in different areas.
f) The procedures and safeguards for the prevention of accidents which may cause environmental pollution and providing for remedial measures for such accidents.

The power of entry and inspection, power to take sample etc. under this Act lies with the Central Government or any officer empowered by it.

For the purpose of protecting and improving the quality of the environment and preventing and abating pollution, standards have been specified under Schedule I-IV of Environment (Protection) Rules, 1986 for emission of gaseous pollutants and discharge of effluents / waste water from industries. These standards vary from industry to industry and also vary with the medium into which the effluent in discharged or the area of emission. For instance, the maximum permissible limits of B.O.D (Biochemical Oxygen

Demand) of the waste water is 30 ppm if it is discharged into inland waters, 350 ppm if discharged into a public sewer and 100ppm, if discharged onto land or coastal region. Like-wise, emission standards vary in residential, sensitive and industrial area. Naturally the standards for sensitive areas like hospitals are more stringent. It is the duty of the Pollution Control Board to check whether the industries are following the prescribed norms or not.

Under the Environmental (Protection) Rules, 1986 the State Pollution Control Boards have to follow the guidelines provided under schedule VI, some of which are as follows.

a. They have to advise the Industries for treating the wastewater and gases with the best available technology to achieve the prescribed.
b. The industries have to be encouraged for the recycling and reusing the wastes.
c. They have to encourage the industries for recovery of biogas, energy and reusable materials.
d. While permitting the discharge of effluents and emissions into the environment, the State Boards have to take into account the assimilative capacity of the receiving water body.
e. The Central and State Boards have to emphasize on the implementation of clean technologies by the industries in order to increase fuel efficiency and reduce the generation of environmental pollutants.

Under the Environment (Protection) Rules, 1986 and amendment was made in 1994 for Environmental Impact Assessment (EIA) of Various Development Projects. There are 29 types of projects listed under Schedule I of the rule which require clearance from the Central Government before establishing.

Others require clearance from the State Pollution Control Board, when the proposed project or expansion activity is going to cause pollution load exceeding the existing levels. The project proponent has to provide EIA report, risk analysis report. NOC from State Pollution Control Board, Commitment regarding availability of water and electricity, Summary of project report/feasibility report, filled in a questionnaire for environmental appraisal of the project and comprehensive rehabilitation plan, if more than 1000 people are likely to be displaced due to the project.

Under the Environment (Protection) Act, 1986 the Central Government also made the Hazardous Wastes (Management and Handling) Rules, 1989. Under these rules, it is the

responsibility of the occupier to take all practical steps to ensure that such wastes are property handled and disposed off without any adverse effects. There are 18 Hazardous Waste categories recognized under this rule and there are guidelines for their proper handling, storage, treatment, transport and disposal, which should be strictly followed by the owner.

The Environment (Protection) Act, 1986 has also made provision for environmental Audit as a means of checking whether or not a company is complying with the environmental laws and regulations. Thus, ample provisions have been made in our country through law for improving the quality of our environment.

WATER (PREVENTRION AND CONTROL OF POLLUTION) ACT, 1974.

It provides for maintaining and restoring the wholesomeness of water by preventing and controlling its pollution is defined as such contamination of water, or such alteration of the physical, chemical or biological properties of water, or any which is likely to cause a nuisance or render the water harmful or injurious to public health and safety or harmful for any other use or to aquatic plants and other organisms or animal life.

Objectives:

1. Prevention and control of water pollution.
2. Maintaining or restoring the wholesomeness of water
3. Establishment of boards of the prevention and control of water pollution.

The salient features and provisions of the Act are summarized are as follows:

a. It provides for maintenance and restoration of quality of all types of surface and ground water.
b. It provides for the establishment of Central and State Boards for pollution control.
c. It confers them with powers and functions to control pollution.

The Central and State Pollution Control Boards are widely represented and are given comprehensive powers to advise, coordinate and provide technical assistance for provide technical assistance for prevention and control of pollution of water.

i) The Act has provisions for funds, budgets, accounts and audit of the Central and State Pollution Control Boards.
ii) The Act makes provisions for various penalties for the defaulters and procedure for the same.
iii) The main regulatory bodies are the Pollution Control Boards, which have been conferred the following duties and powers.

Central Pollution Control Board (CPCB)

i) It advises the central govt. in matters related to prevention and control of water pollution
ii) Coordinates the activities of State Pollution Control Boards and provides them technical assistance and guidance.
iii) Organizes training programs for prevention and control of pollution.
iv) Organizes comprehensive programs on pollution related issues through mass media.
v) Collects, compiles and publishes technical and statistical data related to pollution.
vi) Prepares, manuals for treatment and disposal of sewage and trade effluents.
vii) Lays down standards for water quality parameters.
viii) Plans nation-wide programs for prevention, control or abatement of pollution.
ix) Establishes and recognizes laboratories for analysis of water, sewage or trade effluent sample.

The State Pollution Control Boards also have similar functions to be executed state level land are governed by the directions of CPCB. The Board advises the state govt. with respect to the location of any industry that might pollute a stream or a well. It lays down standards for effluents and is empowered to take samples from any stream, well or trade effluent or sewage passing through an industry.

The State Board is empowered to take samples of trade effluent in accordance with the procedure laid down in the Act. The sample taken in the presence of the occupier or his agent is divider into two parts, sealed by both parties and sent for analysis to some recognized lab. If the samples do not conform to the prescribed water quality standards (crossing maximum permissible limits), then 'consent' is refused to the unit.

Every industry has to obtain consent from the Board (granted for a fixed duration) by applying on a prescribed Proforma providing all technical details, along with a prescribed fee following which analysis of the effluent is carried out. The Board suggests efficient methods for utilization, treatment and disposal of trade effluents.

The Act has made detailed provisions regarding the power of the Boards to obtain information, take trade samples, restrict new outlets, restrict expansion, enter and inspect the units and sanction or refuse consent to the industry after effluent analysis.

While development is necessary, it is all the more important to prevent pollution, which can jeopardize the lives of the people. Installation and proper functioning of effluent treatment plants (ETP) in all polluting industries is a must for checking pollution of water and land. Despite certain weaknesses in the Act, the Water Act has ample provisions for preventing and controlling water pollution through legal measures.

Penalties for violations in this Act:

1. In case of failure of give information by a person discharging effluents into stream or well or regarding construction or establishment of a disposal system, the penalty is imprisonment upto 3 months or fine upto R. 10,00/- or both. If the omission continues, the penalty is an additional fine upto Rs. 5,000/- per day.
2. In case of destroying or damaging the property of the board, obstructing the performance of the Board's functions, failure to furnish information about accidents under sections 31, giving wrong information or making false statements to get Board's constant, the penalty is imprisonment upto 3 months or fine upto Rs.10,000/- or both.
3. In case of violation of order prohibiting discharge of any polluting matter into stream, well or land or violation of control order restraining pollution of water or streams or wells or violation of board order of closure of industry or stoppage of water or electricity supply etc., the penalty is imprisonment for one years to six years and fine.
4. In case of permitting polluting materials into any stream, well or land the penalty is imprisonment for one and a half years to six years or fine or both.

On subsequent conviction the offenders is penalized to imprisonment for two to seven years and fine and the names of the offenders are published in newspapers at offender's expense.

THE AIR (PREVENTION AND CONTROL OF POLLUTION) ACT, 1981.

This act was promulgated in 1981. It is known as **the air (prevention and control of pollution) act, 1981.** It was amended in 1987. Salient features of the act are as follows.

1. This Act provides for prevention control and abatement of air pollution
2. In the Act air pollution has been defined as the presence of any solid, liquid or gaseous substance (including noise) in the atmosphere in such concentration as may be or tend to be harmful to human beings or any other living creatures or plants or property or environment.
3. Noise pollution has been inserted as pollution in the Act in 1987.

4. Pollution control boards at the central or state level have the regulatory authority to implement the Air Act. Just parallel to the functions related to Water (Prevention and Control of Pollution) Act, the boards Performs similar functions related to improvement of air quality. The boards have to check whether or not the industry strictly follows the norms or standards laid down by the Board under section 17, regarding the discharge of emission of any air pollutant. Based upon analysis report consent is granted or refused to the industry.
5. Just like the Water Act, the Air Act has provisions for defining the constitution, powers and function of Pollution Control Boards, funds, accounts, audit, penalties and procedures.
6. Section 20 of the Act has provision for ensuring emission standards from automobiles. Based upon it, the state govt. is empowered to issue instructions to the authority incharge of registration of motor vehicles (under Motor Vehicles Act, 1939) that is bound to comply with such instructions.
7. As per Section 19, in consultation with the State Pollution Control Board, the state government may declare an area within the state as "air pollution control area" and can prohibit the use of any fuel other than approved fuel in the area

causing air pollution. No person shall, without prior consent of State Board operate or establish any industrial unit in the "air pollution control area".

The Water and Air Acts have also made special provisions for appeals. Under Section 28 of Water Act and Section 31 of Air Act, a provision for appeals has been made. An Appellate authority consisting of a single person or three persons appointed by the Head of the State, Governor is constituted to hear such appeals as field by some aggrieved party (industry) due to some order made by the State Board within 30 days of passing the orders.

ISSUES INVOLVED IN ENFORCEMENT OF ENVIRONMENTAL LEGISLATION

We have seen that there are a number of important environmental laws in the form of Acts for safeguarding our environmental quality. But inspite of these acts, we find that we are not able to achieve the target of bringing 33% of our land cover under forests. Still we are losing our wild life. The rivers have been turned into open sewers in many places and the air in our big cities is badly polluted. The status of environment shows that there are drawbacks in environmental legislations and problems in their effective implementation.

Let us examine some important issues related to our acts :

(a) **Drawbacks of the Wildlife (Protection) Act, (1972)**

It seems as if the Act has been enacted just as a fallout of Stockholm Conference held in 1972 and it has not included any locally evolved conservation measures.

The ownership certificates for animal articles (tiger, leopard skins etc.) are permissible which very often serve as a tool for illegal trading.

The Wildlife traders in Jammu and Kashmir easily get illegal furs and skins from other states which after making caps, belts etc, are sold or smuggled to other countries. This is so happening because J&K has its own Wildlife Act and it does not follow the Central Wildlife Act. Moreover, hunting and trading of several endangered species prohibited in other states are followed in J&K, thereby opening avenues for illegal trading in such animals and articles.

The offender of the Act is not subject to very harsh penalties. It is just upto 3 years imprisonment or a fine of Rs.25,000 or both.

(b) **Drawbacks of the Forest (Conservation) Act, 1980** : This Act has inherited the exploitative and consumerist elements from the Forest laws of British period. It has just transferred the powers from state to centre, to decide the conversion of reserve forestlands to non-forest areas. Thus power has been centralized at the top. At the same time, the local communities have been completely kept out from the decision making process regarding the nature of use of forest area. Very often, the tribals who lived in the forest and were totally dependent on forest retaliate when stopped from taking any resources from there and start criminal activities including smuggling, killing etc. The Act has failed to attract public support because it has infringed upon the human rights of the poor native people. They argue that the law is concerned about protecting the trees, birds and animals, but is treating the poor people as marginal. Very poor community participation in the Act remains one of the major drawbacks, which affects proper execution of the Act. The forest dwelling tribal communities have a rich knowledge about the forest resources, their importance and conservation. But their role and contribution is neither acknowledged nor honored.

Efforts are now being made to make up for the gaps in laws by introducing the principles of public trust or Human rights Protection.

DRAWBACKS OF POLLUTION RELATED ACTS

The power and authority has been given to central government with little delegation of power to state government. Excessive centralization very often hinders efficient execution of the provisions of the Acts in the states. Illegal mining is taking place in many forest areas. In Rajasthan alone, about14000 cases of illegal mining have been reported. It becomes more difficult to check such activities at the central level. The provision of penalties in the Act is very insignificant as compared to the damage caused by the industries due to pollution. The penalty is much less than the cost of the treatment/pollution control equipments. This always gives a loose rope to the industries.

The Act has not included the “right to information” for the citizens. This greatly restricts the involvement or participation of the general public.

The Environment (Protection) Act, 1986 regarded as an umbrella, Act, encompassing the earlier two Acts often seems superfluous due to overlapping areas of jurisdiction. For instance Section 24 (2) of the new Act has made a provision that if the offender is punishable under the other Acts like Water Act or Air Act also, then he may be considered under their provisions. Interestingly, the penalty under the older two Acts is much lighter than the new Act. So the offender easily gets away with a lighter punishment.

Under Section 19, a person cannot directly file a petition in the court on a question of environment and has to give a notice of minimum 60 days to the central government. In case no action is taken by the latter, then alone the person can file a petition which certainly delays the remedial action.

Litigation, particularly related to environment is very expensive tedious and difficult since it involves expert testimony, technical knowledge of the issues and terminologies, technical understanding of the unit process, lengthy prosecutions etc.

The state Boards very often lack adequate funds and expertise to pursue their objectives.

A tendency to seek to exercise gently pressures on the polluter and out of the court settlement usually hinder the implementation of legal measures.

For small units it is very expensive to install Effluent Treatment Plant (ETP) or Air pollution control devices and sometimes they have no other option but to close the unit. The Act should make some provision for providing subsides for installing treatment plants or common effluent treatment plants for several small units.

The pollution control laws are not backed by sound policy pronouncements or guiding principles.

Political appointee occupies the position of chairman of the boards. Hence it is difficult to keep political interference at bay.

The Policy statement of the Ministry if Environment and Forests (1992) of involving public in decision making and facilitating public monitoring of environmental issues has mostly remained on paper.

Environmental policies and laws need to be aimed at democratic decentralization of power, community state partnership, administrative transparency and accountability and more stringent penalties to the offender. There is also a need for environmental law education and capacity building in environmental issues for managers.

POPULATION EXPLOSION

The population explosion is defined as "**an imbalance between the rate of growth of population and natural resources in which the population growth is more than the growth of corresponding resources for them**". In fact, a large population is not a problem, if sufficient infrastructural needs of sustaining life are available. Similarly a high population density is also not a problem, provided the means of living are not insufficient. The problem arises when the rate of economic development fails to keep pace with the population growth. Therefore the main factors associated with population explosion in a certain region are i) as how fast the population is growing and ii) is the economic growth also taking place at the same rate.

For example we take Japan and Gambia (West Africa). Although the population density in Japan is too high, yet its economic advances are also high. But in Gambia having a low population density are unable to support their existing population. So we can say that there is a population explosion in Gambia but not in Japan. In order to void this problem we must be follow the Optimum population.

Optimum population: A population which is in balance with the available resources of the country is called optimum population. So it will remain optimum even though the population grows corresponding with the growth of resources.

Population Explosion in India: Population explosion is a worldwide problem. Seriousness of this problem to India can be explained by the following statistics:

1. India's population is 16.9% of world's population but the land area is only 2.4% of the world's area.
2. The rate of population growth is 1.7% as compared the rate of 1.3% of the world's population growth.
3. According to world population data sheet 2000, India's population in 2050 is likely to be 162.8 crores. Thus, India will be the most populated country followed by china.

4. The population density of India which was 304.7/km^2 in 1999, is also likely to rise to about 414.4/km^2 in 2025 and 495/ km^2 in 2050.
5. The life expe4ctancy worldwide has increases from 61 years for male and 66.91 years for female.
6. Most populated and least populated states in India and their population in 2001 are as follows:

UP – 16.6 crores, Maharashtra – 9.67 crores, Bihar – 8.28 crores, Sikkim – 5.4 lakh and Mizoram – 8.91 lakh.

Causes and effects of Population Explosion:

1. It creates problem of food, clothing and shelter.
2. Lack in basic amenities of living such as in water supply, sanitation, health care etc.
3. It builds pressure on economic developments
4. It damages the environment, ecosystem and biodiversity
5. It creates hindrance in education
6. It is responsible for low standard of living
7. It initiates the crisis of food and energy
8. It is responsible for unemployment and under employment and migration to urban areas in search of jobs.
9. It causes the shrinking of areas for agricultural land due to the upcoming townships and construction of houses.
10. It decreases per capita income.
11. It has been observed that the crime rate increases with increase in population.

Strategies to reduce the population Explosion: The population explosion can be reduced by adopting a two ways action via., by checking the birth rate on one kind and by enhancing the resources on the other. Therefore, the following measures can be suggested in this regard by,

1. Educating the people to keep a check on birth rate.
2. Providing incentives in terms of money or kind for structuring a smaller family.

3. Forcing the people t5hrough enforcement of law to limit the size of the family
4. Discovering more natural resources in terms of water, food, energy etc.
5. Discovering newer production techniques to produce more goods and to utilize newer energy resources.
6. Accelerating the process of industrialization.
7. Expending the philosophy of urbanization
8. Finally, wide-spread scheme has to be under taken to educate the people at mass scale.

FAMILY WELFARE PROGRAMMES

It aims at improving the quality of life by reducing the birth rate and increases the national economy through the following objectives:

1. Two children per family
2. Good health to each one
3. Literacy and education to all.
4. Woman's status and employment
5. Child survival
6. Socio-economic development.

Innovative use of mass media and interpersonal communication is made for highlighting the benefit of the small family norms and removal of socio-cultural barriers for adaptation of family limitation programmes.

The following programmes or policies were implemented in India.

1. Family Welfare programme 1977.
2. Rural Health Scheme 1977.
3. National Health Policy 1982.
4. National Population policy 1986.

Popular features of these programmes are as follows:

1. Acceptance of programmes is not forced upon anyone. It is a voluntary basis.
2. Local people are involved at grass root level. Example: the trained female dais in health schemes.

3. Demographic goal was set to achieve a net reproduction rate of 1 child per family by the year 2000.
4. The birth rate of 21/100 and death rate of 9/1000 population was targeted by the year 2000.
5. The attainment of couple protection rate of 60% by the year 2000 was also targeted.

Presently, the family welfare programmes concentrates on Planned Parenthood with one child (male or female child).

Problems of family welfare programmes: Unfortunately, the family welfare programmes is misunderstand as the family planning programmes. The family planning impinges in the minds of people as a forced sterilization programmes birth control. However, there are some problems associated with this programme. These are as follows:

1. Family planning: a woman – centered programme
2. Imbalance in male – female sex ratio
3. doubts about some treatments like pulse – polio movement

Generally women are forced to undergo sterilization or to adopt family planning. This is mainly due to male dominance in society and with in the family. Therefore, in order to remove this problem the male –female counter part should be given equal status.

ENVIRONMENT AND THE HUMAN HEALTH

A physically fit person not suffering from any disease is called a healthy person. However, there are many other dimensions associated with the state of being healthy. Environmental pollution is the serious problems faced by the people in all the country due to increase in population. In India, increase in population leads to maximum use of natural resources which results in pollution on local resource. Environmental pollution in urban areas is associated with excessive morbidity and mortality which are discussed as follows:

Housing and health: The lack of services such as water supply, sanitation, drainage of storm water, improper solid waste management etc leads to pollution related diseases such as respiratory diseases, acute water borne diseases, tuberculosis, meningitis etc.

Health effects Due to Water: The decreases in quality of water cause cholera, diarrhea, hepatitis, typhoid amoebic and bacillary diseases to human being.

Health effects Due to Air: Due to rapid urbanization and industrialization, air get polluted very easily and causes respiratory damage, heart and lung diseases.

Some of the major pollutant and their health hazards are as follows:

Pollutants	Sources	Health hazards
Carbon monoxide	Incomplete fuel combustion	Impairs oxygen carrying capacity o blood
Sulphur dioxide	Burning of sulphur contain fuel	Affects the function of lungs
Nitrogen oxides	Combustion in motor vehicles, power stations furnaces	Eye irritations and coughing
Volatile hydrocarbon	Partial combustion of fuels	Irritation in eyes, Nose and thro problems
Lead	Emission from motor vehicles	Coughing, nausea, breathing difficulties
Oxidants	Emission from motor vehicles	Nervous system slow down and retarde brain development

Control of pollution on Environment and Human Health

1. Reduce the population through information, education and communication.
2. Protect the air pollution by using air pollution control equipments.
3. Wastewater treatment should be adapted in all the industries and municipal sewage before discharging them into local water resources.
4. More efforts should be taken to implement the compulsory environmental education at the school level in order to make people aware of the environment protection.

HUMAN RIGHTS:

India is a democratic country. The aim of our government is to ensure happiness to all the citizens with equal comforts, opportunities and rights. Every citizen enjoys certain rights and has certain duties towards the country.

1. **Right to equality**: All citizens of India are equal in the eyes of law. There should not be any discrimination against any citizen on grounds of religion, language, race, caste, sex or place of birth.
2. **Right to freedom of Speech and Activity:** We have the right to speak, write and express our views freely. We have the right to form associations, groups or unions.
3. **Right against exploitation:** Every individual of the nation has right to fight against exploitation. No child below the age of fourteen can be employed to do work. To force people to work more, to underpay them and to ill-treat and degrade workers are punishable in the court of law.
4. **Right to freedom of religion:** Every Indian has the freedom to follow any religion of his choice. Every citizen has the freedom to practice and propagate any religion.
5. **Cultural and Educational Right:** All citizens in India have the right to establish and maintain educational institution of their own choice. They also have the right to conserve their language, script and culture. One can pursue any course of education. He is free to study in the institution of his choice. He can follow any culture he likes.
6. **Right to constitutional Remedies:** If a citizen is denied any of these fundamental rights, he or she can appeal to the High Court or Supreme Court for protection. The high court and the Supreme Court have the powers to preserve and protect the fundamental rights of the citizens.

In addition to these fundamental rights, our constitution also provides some political rights to every citizen of India. They are:

1. All citizens have the right to vote to elect people to form government. The minimum age for voting is 18.
2. Every citizen, who has qualification prescribed by the constitution, has the right to contest in the election to the Union or state local body.
3. All citizens enjoy the right to hold public or government office, if they satisfy governing these posts.
4. A citizen can become a member of any political party.

In return for the right, every citizen is expected to perform certain duties. The duties expected of every citizen are as follows:

1. To obey the laws of the country
2. To respect the National flag and the national Anthem
3. To pay taxes honestly
4. To respect the right of other citizens
5. To defend the country in times of distress
6. To protect public property and to avoid violence
7. To keep our surroundings clean
8. To respect every religion
9. To cast our votes honestly
10. To work for the unity of the country.

WOMAN AND CHILD WELFARE:

Women and children are very important identities of human society. The adult women are the creators of next generation, and the children are the hopes of future. Therefore, they should be cared to utmost degree. No doubt, their welfare is being looked after by societies and families. However, this is just not sufficient. In this regard, Governments also devise and implement various welfare measures for them. Some of the women and child welfare measures are listed as follows.

1. Sarwa Siksha Abhiyan
2. Balika Samridhi Yojana
3. Indira Mahila Yojana
4. Programme of Development of women and Children in Rural Areas
5. Mahila Samridhi Yojana
6. Integrated Child Development Services
7. Employment and Income Generating Training-cum-Production Centres
8. Rashtriya Mahila Kosh
9. Day-Care Centres of Crutches for Children
10. Short Stay Home for Women and Girls

Problems affecting Women and Child Welfare: Women and child welfare is affected by the following manor problems:

1. Under nourishment
2. Malnutrition
3. Limited education
4. Lower socio-economic status
5. Infections
6. Sexual harassment and abuse
7. Forced for uncontrolled reproduction (women only)

A brief discussion on these issues is given below:

Under nourishment: Under nourishment means the lack of sufficient calories in food. The lack of energy and nutrients make them prone to infectious diseases. In causes weakness and sickness also. Mainly the poor women and children are severely influenced by it. They are generally subjected to following ill-effects.

1. weakness and giddiness
2. lower working efficiency due to weakness
3. sickness at increased frequency
4. poor growth of children
5. social and mental disorders
6. mental retardation

Malnutrition: Malnutrition means lack of specific ingredients such as vitamins, proteins, minerals, etc. in the food. Pregnant women, nursing mothers and children are more susceptible to malnutrition. In causes the following ill effects in women and children.

1. Kwashiorkor i.e. failure of neural development in infants leading to disabilities in learning. It is mainly caused due to lack of protein in the diet.
2. illness like anaemia, goiter, pellagra etc.
3. less weight of child at birth
4. high rate of child mortality

5. Miscarriages, maternal depletion, toxemias of pregnancy in pregnant women.

According to demographic data and estimates, the projections in the year 2002 for India are as follows.

- Infant mortality rate = 68
- Life expectancy at birth (total life) = 633.

Limited education: The number of school going children is still for from satisfactory. Less than 50% reach to primary school. Also a substantial number of them drop out at elementary level. The drop-out rate of girls is much higher than those of the boys. It is probably because the girls have to perform many household works also. The literacy rate of women and children as given below reveals more facts in this regard.

Literacy rate in the year 2001 at national level = 65.38%

- The literacy rate in males = 75.85%
- The literacy rate in female = 54.16%

Lower socio-economic status: The socio-economic status of women is generally lower in under-developed countries. This can be understood well be the fact that the number of school going boys at all levels of education is generally more than the number of girls. Also the grown up and adult women are dependent on their male (husband, father, brother etc.) family members in respect of social and economical decisions.

The lower socio-economic status of women and children can also be understood by the following statistics.

- Women labour force in the year 2001 was = 90 million
- Child labour force in the year 2001 was = 11.28 million.

QUESTION BANK

UNIT – I (PART – A)

1. Define environmental science and environmental engineering.
2. What are the important components of environment?
3. Define natural resources with types
4. Draw an interrelationship of various essential components of environment.
5. State the significance and scope of environmental education.
6. What is Biosphere?
7. What are the functions of lithosphere?
8. State the need for public awareness for solving environmental problems.
9. What are renewable resources? Give example.
10. How are forest classified?
11. What are the preventive measures of deforestation?
12. What are the consequences of timber extraction?
13. State the environmental effects of extracting and using mineral resources.
14. Mention the consequences of flood.
15. Define overgrazing.
16. State the problems caused by the construction of Dam.
17. What is deforestation? Give two reasons for it.
18. What water logging? Mention the problems of water logging.
19. Write any four functions of forests.
20. What is meant by soil erosion?
21. Write any two adverse effects caused by overgrazing.
22. Differentiate renewable and non-renewable sources of energy.
23. What is meant by eutrophication?
24. Write short note on mineral resources of India.
25. List any four adverse effects of mining.
26. What is salinity? Write the impacts of it.
27. What is land slide?
28. What is desertification? Give the reason for it.
29. What are the ecological benefits forests?
30. What do you meant by surface and underground mining?

Part – B (8 Mark)

31. Explain the major causes and consequences of deforestation.
32. a. Enumerate the ecological effects of deforestation.
    b. Explain the effect of over utilization of surface and ground water
33. Explain the various methods of mineral extraction. How it affects the environment.
34. Describe the water resource problems

35. What is meant by Forest recourses? Explain its types, function and uses.
36. Explain the various renewable energy sources in the earth.
37. Give the brief account on the following Renewable and Non-renewable energy resources.
    a. Solar energy
    b. Hydropower energy
    c. Nuclear energy
38. Discuss the role of an individual in conservation of Natural resources.
39. Discuss the effects of dams on forests and tribal people.
40. Discuss the various types of land degradation with its causes and solutions

U NIT – II (Part – A)

1. Define the term ecosystem.
2. What do you meant by biodiversity? Write the classification of biodiversity.
3. Distinguish between food chain and food web.
4. What is ecological succession?
5. What are endemic and endangered species? Give an example each.
6. Define the term hot spots biodiversity. What are the hot spots found in India?
7. Distinguish between the species diversity and ecosystem diversity.
8. What are tropical levels or feeding levels?
9. What is primary productivity of ecosystem?

Part – B (8 Marks)

1. Describe the structure and function of various components of an ecosystem.
2. Explain the factors and merits of conservation of biodiversity.
3. Discuss the threats faced by Indian biodiversity.
4. Brief explanation about Ecological pyramids
5. Explain the energy flow of an ecosystem on the basis of thermodynamics.
6. What is ecological succession? Describe the stages of succession.
7. Discuss the direct and indirect values of biodiversity.

UNIT – III (Part – A)

1. Define pollution. Name various atmospheric pollutants.
2. Differentiate between point and non-point sources of water pollution.
3. Define acid rain.
4. What is meant by Global warming?
5. List any two air pollutants and their effects on plants.
6. What are the sources of radioactive pollution?
7. Mention the causes and effects of acid rain.
8. What is biomagnifications
9. What is photochemical smog?
10. Give an example for primary and secondary air pollutant
11. Define thermal pollution.

Part – B (8 Marks)

1. Illustrate about causes and effect of Ozone layer depletion.
2. What is meant by Nuclear Holocaust, explain its effects and control measures.
3. Enlist and explain the water pollution and control measure of water pollution.
4. Give an account of the adverse effects of the water pollution and nuclear pollution.
5. Explain the causes, effects and control measures of soil pollution.
6. Define thermal pollution. Enumerate the causes, effects and control measures of thermal pollution.
7. Explain the following.
   a. Acid rain
   b. Global warming
   c. Ozone layer depletion
8. Enumerate the causes and effects noise pollution.
9. Discuss the sources, effects and control measures of radioactive pollution.
10. Describe the effects of air pollution on materials and climates

UNIT – IV (Part –A)

1. What is autoclaving? How is it useful for the treatment of biomedical waste?
2. Write two effects of biomedical waste
3. Define hazardous waste.
4. What is green chemistry?
5. Define the term earthquake
6. Mention the sources of Biomedical waste
7. State the meaning for cleaner technology.
8. What is bioremediation
9. What is meant by composting?
10. What is pyrolysis?
11. Mention the primary and secondary treatment involved in municipal sewage treatment.
12. How will you characterize the hazardous waste?
13. What is solid waste? Give an example.
14. Write the disposal method methods of solid waste.
15. What are the different types of solid wastes?

Part – B (8 Marks)

1. Brief about the causes and effects of Tsunami.
2. Discuss briefly causes, displacement methods of biomedical waste.
3. Discuss elaborate about Floods.
4. Describe in detail the following disaster management:
   a. Tsunami
   b. Cyclone

c. Earthquake

5. Describe the following methods:
   a. Composting
   b. Pyrolysis
   c. Sanitary land filling
   d. Coagulation
   e. Adsorption process
6. Describe the ten categories involved in biomedical waste management.
7. Explain the various treatment methods involved in municipal sewage waste waste management
8. Explain the physical, chemical and biological treatment of hazardous waste.
9. Discuss about the waste minimization techniques.

Unit – V (Part –A)

1. What is meant by rain water harvesting?
2. State the precautionary principle.
3. List out the objectives of air act.
4. What is environmental impact statement?
5. Write short note on population explosion
6. Define waste lands and it types.
7. Define polluter
8. State polluter pay principle.

Part – B

1. Explain the Air pollution prevention Act
2. Explain the objectives, concept and methods of rain water harvesting
3. Brief explanation about resettlement and rehabilitation of people.
4. Describe and explain about ' Child welfare'
5. Enumerate the various proves involved in environmental impact assessment (EIA)
6. What are the components of integrated watershed management? Explain.
7. Discuss the various objectives, salient features and penalty of Air Act and Water Act.
8. Explain polluter pay principle and precautionary principle.
9. Define Human Rights and discuss the salient features of the Universal Declaration of Human Rights by UN.